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- Appendix C. Citizen Summary, *Plan of Study Report*, by the U.S. Geological Survey, 1996.
- Appendix D. Citizen Summary, *Middle Rio Grande Water Assessment*, by the U.S. Bureau of Reclamation, 1997.
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# Abbreviations

AACE	American Association of Costing Engineers
ac-ft	acre-feet
ac-ft/yr	acre-feet per year
AMAFCA	Albuquerque Metropolitan Arroyo Flood Control Authority
ASR	aquifer storage and recovery
BMMR	Bureau of Mines and Mineral Resources
cfs	cubic feet per second
EIS	environmental impact statement
EPA	Environmental Protection Agency (U.S.)
gpcd	gallons per capita per day
gpm	gallons per minute
mgd	million gallons per day
mg/L	milligrams per liter
µg/L	micrograms per liter
MRGCD	Middle Rio Grande Conservancy District
NEPA	National Environmental Policy Act
NMED	New Mexico Environment Department
NPDES	National Pollution Discharge Elimination System
NPW	net present worth
O&M	operation and maintenance
ppb	parts per billion
ppt	parts per trillion
SDWA	Safe Drinking Water Act
SEO	State Engineer Office
SJC	San Juan-Chama
SWRP	Southside Water Reclamation Plant
UNM	University of New Mexico
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

# Chapter 1

## Introduction

This report covers work performed from March 1996 through February 1997 to prepare the Albuquerque Water Resources Management Strategy project. The City of Albuquerque Public Works Department asked the consulting engineering firm of CH2M HILL in association with Simms & Stein, P.A.; Camp Dresser & McKee; Applied Decision Analysis, Inc.; Lee Wilson and Associates; and Southwest Water Consultants to complete this work.

The goal of the Water Resources Management Strategy project is to devise and implement a long-range water resources plan that will provide a safe and sustainable water supply for City water customers to 2060. This goal is derived from the policy directives of the *Albuquerque/Bernalillo County Comprehensive Plan*, which calls for providing “a permanent, adequate supply” and for the City to “maintain a dependable, quality supply of water.”

The approach has been to conduct the studies and develop the concepts that will enable the City to make the best use of the resources it now owns and to investigate and pursue the potential future sources of supply as needed. In addition to work completed as part of the Water Resources Management Strategy project, the City has sponsored and coordinated a series of studies to gain a more accurate understanding of Middle Rio Grande Valley hydrogeology and water management considerations. These studies provided the foundation for the Water Resources Management Strategy project.

Phase 1 of the Water Resources Management Strategy development project, *San Juan Chama Diversion Project Options*, was completed in 1995. The project team developed generic strategies and analyzed their probable consequences in terms of adequacy of supply and environmental, institutional, legal, and cost factors. The order-of-magnitude cost estimates developed included both capital and operations and maintenance costs, calculated on a net present value basis. Refer to the Phase 1 *Summary Report* (CH2M HILL, 1995) for a full discussion of this work or to Appendix A of this report for a summary.

## Phase 2 Tasks

In Phase 2, the project team built on previous work to:

- Develop 32 specific project alternatives, including several ways of implementing each of the basic strategies developed in Phase 1 and “no-action” alternatives that assume continuation of the current practice of relying solely on local ground water, with and without achievement of conservation goals.
- Develop cost estimates and initial evaluations of environmental and other consequences of implementing the alternatives. This included conducting preliminary environmental studies to clarify potential effects of various alternatives, especially with regard to effects on river flows and the bosque.
- Develop criteria and measures of performance for scoring alternatives that reflect ratepayer concerns about the impacts of water resources strategy on rates, the environment, and the long-term ability of the City to maintain a healthy economy and its quality of life.

- Conduct a preliminary evaluation of the alternatives that allowed broad participation in continuing to shape the criteria and in determining the factors that would lead to a successful strategy.
- Refine the initial alternatives and evaluation to work toward a strategy that could do a good job of simultaneously satisfying a wide variety of criteria. The final evaluation also considered how well the alternatives would be able to accommodate a range of potential future changes in areas where major unknowns still exist, such as the future standards and rules that could be imposed by regulatory agencies.
- Define a recommended strategy that delineates appropriate policies, actions, and an implementation program. Explaining the recommended strategy is one of the primary purposes of this report.
- Continue analysis of the types of future water supplies that show promise and the steps that would be required to make them available to the City.
- Conduct a public involvement program that took into account the range and concerns of stakeholders involved in water resources issues, including ratepayers; other City and County Departments; private users of the aquifer; local, state, and federal agencies and regulators; the Pueblos; other jurisdictions within the region, such as the Middle Rio Grande Conservancy District (MRGCD) and neighboring cities; and community groups with interest in specific areas such as the environment, economic development, and neighborhood issues.

In all these activities, both actions the City could take unilaterally and the potential for regional cooperation were taken into account. While the Water Resources Management Strategy project is not regional in scope, Albuquerque's role as the major user of the aquifer means that any City strategy will affect other regional water users.

## Why a New Strategy is Needed

For more than a hundred years, the Middle Rio Grande Valley has relied on ground water within the Albuquerque basin (see Figure 1-1) to supply most of its domestic water needs without suffering any visible adverse effects. The City of Albuquerque uses ground water exclusively. Why change a strategy that has worked so well?

The Rio Grande is the major source of water refilling the aquifer to provide these ground-water supplies on a sustainable basis. Our understanding of how—and how quickly—this aquifer recharge occurs has changed dramatically. Today we know that about half of the water the City of Albuquerque pumps from the aquifer each year is not replenished. Underground water levels are declining, in some areas at a worrisome rate. As they decline, water quality may deteriorate. These are indications that the traditional approach to water resources management is not providing a safe and sustainable supply for Albuquerque.

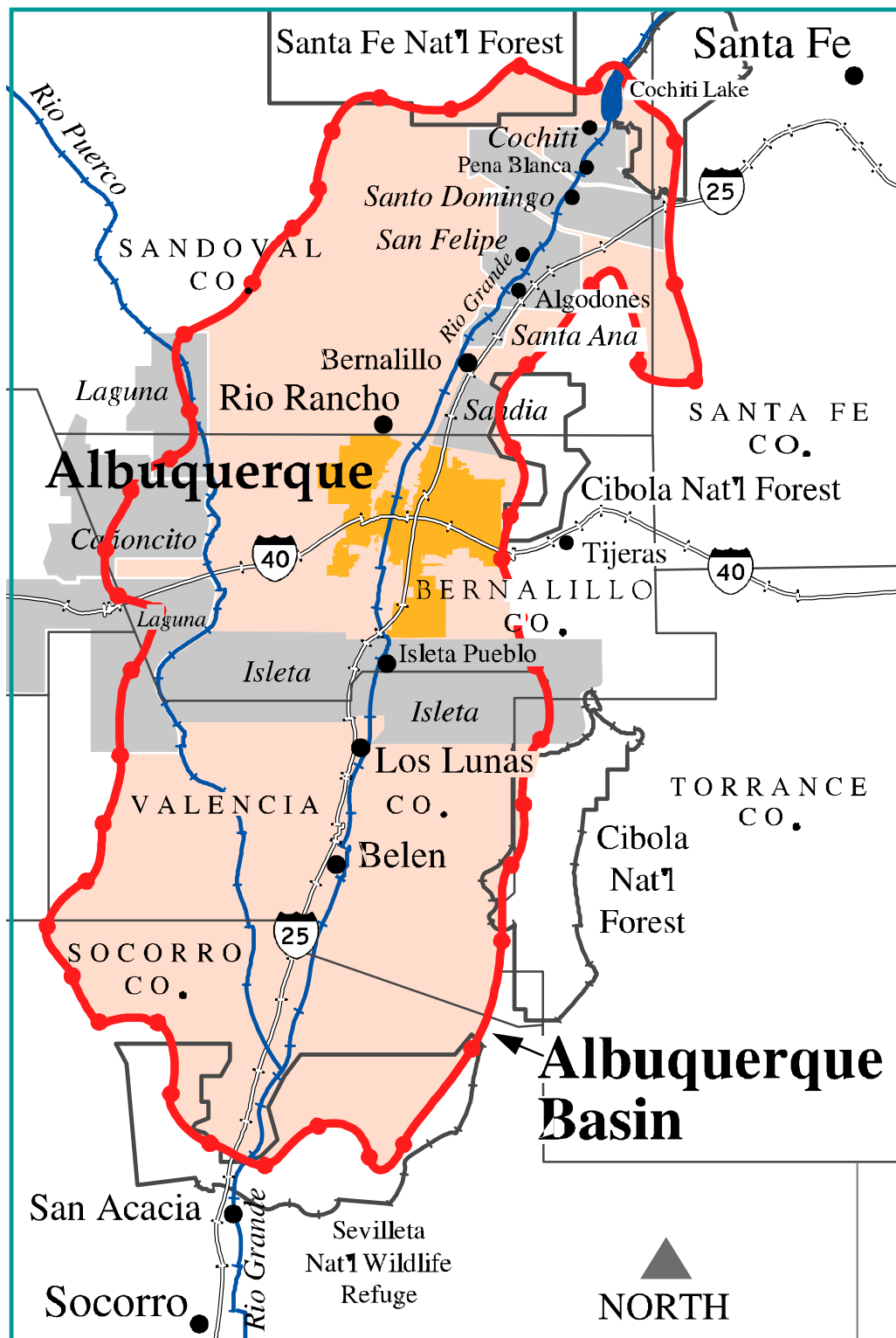


Figure Chapter 1 -1. The Albuquerque Basin

## How the Policies of the Past 30 Years Came Into Being

During the 1950s and 1960s, rapid population growth spurred concerns about water management, and New Mexico adopted a new regime of water regulation and administration. The strategy Albuquerque and other regional users of the aquifer have followed to the present day was shaped during this period.

Major studies conducted at that time outlined a picture of the Albuquerque basin and the aquifer that underlies the Middle Rio Grande Valley from Cochiti Lake on the north to San Acacia on the south. Based on data gathered primarily from near the Rio Grande where it passes through the Albuquerque metropolitan area, experts devised a model of the aquifer.

The model assumed that water from the Rio Grande seeped rapidly through deep, relatively uniform layers of porous rock, sand, and soil throughout much of the basin. The more water users pumped out, the faster this seepage was assumed to occur. The assumption implies that the ground-water supply is virtually unlimited, because it is constantly renewed by the river.

Based on this model, the state's primary water regulatory agency, the State Engineer Office (SEO), adopted a formula to calculate how much water users pumping from the aquifer were causing to be lost from Rio Grande flow. In order to pump larger amounts of ground water, these users have been required to secure rights to water flowing through the Rio Grande so that downstream water rights holders will be assured that the river is "kept whole" and is not depleted before their water reaches them.

Community leaders in Albuquerque during the 1950s realized that as the City grew and needed more water, they would have to add ever-increasing amounts of water to the Rio Grande to meet the State Engineer's requirement that they "keep the river whole."

In response to the needs of Albuquerque basin water users, the U.S. Bureau of Reclamation (USBR) built the San Juan-Chama Diversion Project to provide water to supplement Rio Grande flows. The San Juan-Chama project consists of a series of facilities that divert water from the Colorado River basin in southern Colorado, channel it through 26 miles of tunnels under the Continental Divide, and discharge it into the Rio Chama in the Rio Grande basin. Heron Reservoir, near where the Rio Chama flows into the Rio Grande, was built to store San Juan-Chama water (see Figure 1-2).

As one of the participants in the San Juan-Chama project, the City of Albuquerque contracted for 48,200 acre-feet per year (ac-ft/yr) of this water. The plan was to use the water to supplement Rio Grande flows so that the City could pump the amounts of ground water it would need to serve City water customers in the 1990s and beyond. Community leaders at the time were well aware of growing competition for water in the arid Southwest. Their foresight reserved this water for Albuquerque at a cost far lower than would be paid today and assured that the City would have a renewable supply far into the future.

Thus, the traditional strategy has been to rely exclusively on ground water for the City's municipal water supply, with the understanding that San Juan-Chama water would be released into the Rio Grande as needed to enable the City to increase ground-water pumping.

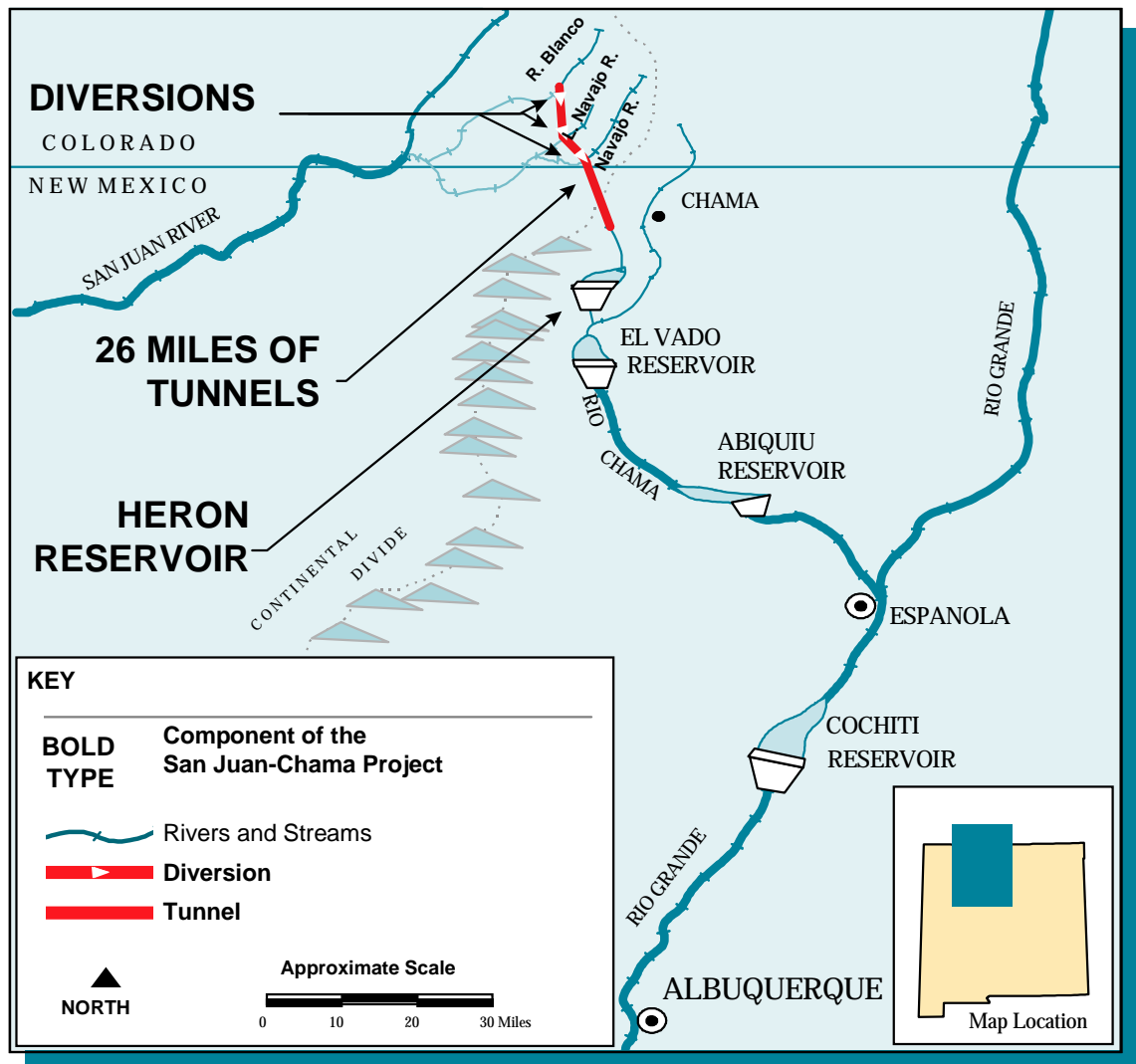


Figure Chapter 1 -2. San Juan-Chama Diversion Project

In the intervening years, the City has stored, leased, and exchanged portions of its San Juan-Chama water to help defray the City's share of the costs of operating the project. In recent years, the City has made the first releases of San Juan-Chama water to the Rio Grande comply with the State Engineer's rules for compensating for pumping-induced losses to Rio Grande flows.

## The Evolution of a New Understanding

In the 1980s, the City realized that the State Engineer's model did not account for the situation they found in managing the water supply. Instead of being rapidly replenished, the aquifer was showing a net loss in the form of declining water tables. In addition, as water levels declined, so did water quality. Higher concentrations of naturally occurring

arsenic were found as wells were drilled deeper into the aquifer. Two wells have since been removed from service due to the arsenic in the water they produce.

In 1988, the City initiated a series of studies carried out by highly qualified experts from a variety of federal and state agencies, academia, and the private sector. They gathered much more data on the aquifer over a larger area than had their counterparts of the 1950s. They looked at a broad range of factors and took advantage of advances in computer modeling and other technology in conducting their work.

From these studies a dramatically different picture of how the aquifer works has emerged. Some of the primary studies have been:

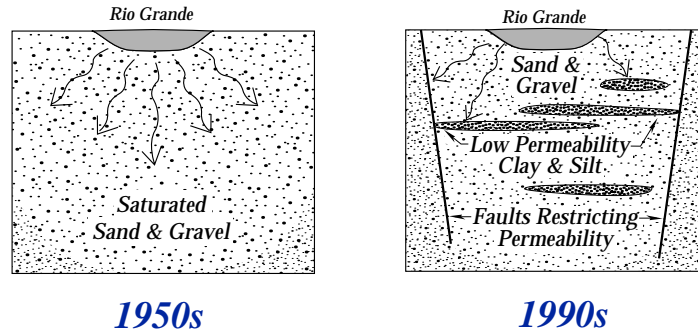
- *Deep Hole Test Drilling Program*, City of Albuquerque, 1988-1991
- *Hydrogeologic Framework of the Northern Albuquerque Basin*, New Mexico Bureau of Mines and Mineral Resources, 1992
- *Geohydrologic Framework and Hydrologic Conditions in the Albuquerque Basin, Central New Mexico*, U.S. Geological Survey, 1993
- *Simulation of Ground-Water Flow in the Albuquerque Basin, Central New Mexico, 1901-1994, with Projections to the Year 2020*, U.S. Geological Survey, 1995
- *Middle Rio Grande Water Assessment*, U.S. Bureau of Reclamation with the New Mexico Bureau of Mines and Mineral Resources, 1997

The U.S. Geological Survey (USGS) studies mentioned above included a new computer model that simulates the workings of the aquifer, showing how water tables would be affected by pumping. Based on the extensive data the agency used, the USGS model portrays the aquifer as smaller and less unified than the 1950s model did. (See Figure 1-3 for a schematic diagram of the differences between the 1950s model and the 1990s model of the aquifer.)

The new model shows that the most productive layers of the aquifer are thinner and less extensive than was previously believed. While the aquifer itself is very large, much of it consists of geologic materials that are difficult to extract water from.

**Figure Chapter 1 -3. A New Understanding of the Aquifer**

# Conceptual Model



**Figure Chapter 1 -4. The River Loses Less Water to the Aquifer than Previously Thought**

In addition, geological faults and other irregularities run through the aquifer, forming barriers that prevent water from spreading. In some areas, as illustrated schematically in Figure 1-4, clay layers cut off the flow of water underground. The connection with the Rio Grande is more complex and less direct than the old model assumed.

The formula devised in the 1950s substantially overestimates the amount of water seeping into the aquifer from the Rio Grande. Adding more of the City's San Juan-Chama water to the Rio Grande will not by itself assure Albuquerque a sustainable water supply. Instead of recharging the aquifer, the San Juan-Chama water would simply flow downstream while water table levels continue to decline.

The City has also commissioned other studies that help to put these changes in context. Two that defined critical issues and have played a role in defining what will need to be done in the future are:

- *The Value of Water*, by F. Lee Brown, S. Christopher Nunn, John Shomaker, and Gary Woodard, January 1996. One influential concept to emerge from this study was the creation of a drought reserve, which preserves water in the aquifer for use when it has the highest economic and quality-of-life value. The study also considers price elasticity and the balance of competing uses in terms of urban activities, agriculture, and maintenance of the bosque. In general, the study concludes that current rates do not reflect the value of water and therefore foster low-value uses of water that in an economically rational world would be eliminated. The study recommends that water be priced in accordance to its worth, including the full costs of supplying it. A summary appears in Appendix B.
- *Plan of Study Report*, U.S. Geological Survey, March 1996. The new USGS model raised understanding of the aquifer to a new level, but also made it clear that much is still unknown. Outside of the metropolitan area data are still sparse. And even within the metropolitan area where most of the deep wells occur, the complex hydrogeologic system is far from completely understood. The City, the State Engineer Office, and others who make far-reaching decisions based on their understanding of the aquifer needed an organized plan of study that would help resolve outstanding questions. This report draws up that plan, specifying key studies that remain to be done and the order in which they should be conducted. A summary appears in Appendix C.

## Issues to be Addressed

The consensus among water experts is that City's traditional water management strategy of relying exclusively on ground water and using its San Juan-Chama water to compensate for pumping-induced losses to the Rio Grande cannot provide a sustainable water supply.

Phase 2 of the Water Resources Management Strategy project, therefore, addressed the following issues:

- The ground-water supply is limited and can be exhausted if long-term mining of the aquifer continues. Only about half of the amount the City now pumps can be provided on a sustainable basis.
- The City's current programs to implement the City/County Ground Water Protection Policy and Action Plan and to achieve conservation goals are important aspects of overall water management strategy.
- Continuing past practices will inevitably lead to such severe water table declines that the aquifer will become compacted, causing subsidence of the land surface and permanent damage to the water-bearing capacity of the aquifer.
- To use its San Juan-Chama water, the City must take it from the Rio Grande. This implies finding a means of getting the water from the river and determining the best ways to use it. Most uses imply providing water treatment facilities.
- Failure to put San Juan-Chama water to beneficial use jeopardizes the City's claim to this water, because "use it or lose it" is a well-established tenet in water law and many competing users exist.
- Administrative rules and institutional frameworks play a large role in determining what options are open. Work must concentrate not only on engineering solutions, but also on legal, administrative, and institutional aspects of the problem.
- While all studies to date indicate that using the water the City already owns is the surest and least expensive way to achieve a safe and sustainable supply, other sources of water are potentially available and merit investigation. Over the long term, additional supplies will be needed.
- The information now available needs to be disseminated among all the users of the aquifer and those with authority in Middle Rio Grande Valley water issues. The regional nature of the resource—and of the consequences of water strategies—is clear.
- Efforts to arrive at a common regional understanding and consensus on planning have not yet borne fruit. The City continues to seek productive cooperative approaches to take with neighboring jurisdictions including the Middle Rio Grande Conservancy District.
- Although great strides have been made in our understanding of the aquifer, much more remains to be learned. The City has a leadership role to play in identifying, pursuing, and sharing the results of new study and inquiry.

## About This Report

This report summarizes the methodology and findings of Phase 2 of the Water Resources Management Strategy. It includes an executive summary of Phase 2 at the front. The appendices include summaries of several related projects and a summary of public

involvement activities. For more detailed information and technical data, refer to *Evaluation of Alternatives and Strategy Formulation: Technical Basis for the Recommended Strategy* (CH2M HILL, 1997a).

Project documents, including this report, are available for review in the reading area of the Public Works Department on the 5<sup>th</sup> floor of City Hall. Copies of the executive summary, the Summary Report, and other documents related to the Water Resources Management Strategy project may be requested by calling the Water Resources Information Line: 768-3619.

# Chapter 2

## The Alternatives

### Where Ideas for Alternatives Came From

In formulating alternatives, the project team built on past work conducted for the Water Resources Management Strategy project and other studies, as well as on years of discussions that have taken place in the technical community. Public forums and meetings with community groups also allowed the general public and community leaders to offer potential solutions. These sources of ideas included many overlapping concepts, and all contributed to the wide-ranging consideration of options open to the City.

The project team sought only feasible alternatives for evaluation. Drawing on past work and development of environmental, institutional, and cost information, some potential alternatives were eliminated early on due to lack of feasibility.

For example, any alternative that posed serious risks to public health, safety, or the environment was rejected before detailed work began. Alternatives that included features that were clearly far more expensive and difficult to implement were also eliminated. An example is the diversion of San Juan-Chama water at Cochiti Lake. This diversion method is technically feasible, but would involve permitting and construction of a pipeline from the lake to Albuquerque. This was deemed so difficult to implement due to cost, permitting, and acceptance problems that it was excluded from the development of specific alternatives.

The alternatives focus on water the City already owns and/or can begin planning to use immediately. Earlier preliminary study of supply options involved water the City does not own, such as purchase of additional water rights, capture of stormwater, and importation of water from other basins. While important in the longer term, none of these options is competitive with the sources the City already has at hand: conservation, San Juan-Chama water, and purified recycled wastewater.

Promising ideas that require major changes in institutional structures or legislation were maintained for consideration, but are on the list of potential sources of supply for the long-term future, when existing supplies are no longer sufficient.

### Phase 1 Ideas for Alternatives

Phase 1 of the Water Resources Management Strategy, called San Juan-Chama Diversion Project Options, focused on developing generic alternatives for achieving a safe and sustainable water supply. The Phase 1 report (see Appendix A for an executive summary) laid out four basic approaches to using water the City now owns and analyzed them in terms of aquifer protection, approximate cost, permitting needs, adequacy of institutional mechanisms, and potential environmental consequences. This provided the foundation for developing many alternatives in Phase 2. The four basic approaches from Phase 1 are:

- Continuing to rely solely on ground water, either by drawing down the local aquifer or by developing new wellfields outside the City. A base case in which past practices and consumption patterns continued was considered. A second alternative considered using only local ground water, but took into account achievement of conservation goals.

- Using one of several potential means to divert San Juan-Chama water from the Rio Grande and use the water to recharge the aquifer, either through spreading basins, arroyos, injection wells, or aquifer storage/recovery wells.
- Using one of several potential means to divert San Juan-Chama water from the Rio Grande and use the water as a direct part of the City's municipal water supply.
- Recycling water from the Southside Water Reclamation Plant and using it to recharge the aquifer or for nonpotable water needs. Other recycling options used smaller sources of water, such as industrial facilities, to create nonpotable water supplies for local areas.

Phase 1 reviewed and eliminated some methods of taking water from the Rio Grande as infeasible. Methods considered were:

- Diversion at Cochiti Lake and construction of a pipeline to bring the water to Albuquerque (considered infeasible primarily due to cost, permitting, environmental, and acceptance problems)
- Diversion at the Middle Rio Grande Conservancy District's (MRGCD) Angostura diversion and construction of a pipeline to bring the water to Albuquerque (considered infeasible due to cost, permitting, environmental, and acceptance problems)
- Diversion using existing MRGCD facilities, for example at their Angostura diversion using MRGCD canals and ditches to bring the water to Albuquerque (considered technically feasible, but not without institutional acceptance or environmental problems)
- Construction of a new surface diversion structure on the Rio Grande near Albuquerque (considered infeasible due to problems with environmental impacts, permitting, and public acceptance)
- Construction of underground infiltration galleries near the Rio Grande in the Albuquerque metropolitan area (considered feasible)

## Contributions of the Water Assessment Study

The U.S. Bureau of Reclamation's *Middle Rio Grande Water Assessment* study (see Appendix D for a summary) considered ways to enhance recharge of the aquifer and to use shallow ground water. It also looked at how land-use practices affect recharge and at potential institutional arrangements. The study comprised a compilation of 20 component technical studies carried out under the Bureau's General Investigations Program.

Study findings explored approaches that use the riverside drains and existing irrigation facilities, apply land-use management involving preservation of agricultural lands and farming practices, and institute water banking, among other ideas. The study strongly recommended conjunctive use, a term that refers to drawing on a variety of water supplies and matching the quality of water provided by each to the needs of users for irrigation, industrial process, and domestic water supplies.

The project team integrated these concepts in the process of developing alternatives.

## Contributions of Wastewater Studies

The City's Wastewater Department has conducted a series of studies on the potential for recycling all or part of the wastewater it collects from throughout the service area. The

initial study, conducted by the consulting engineering firm of Camp Dresser and McKee (CDM) in 1995 was titled *Reclamation and Recharge Feasibility Study Report*. Work completed in 1996 by CDM and CH2M HILL extended the analysis to consider reclamation and recharge of Intel's wastewater on the west side: *Industrial Wastewater Reclamation and Recharge Feasibility Study Report*. These studies investigated sources of wastewater (including individual large-volume water users), treatment needs, and recharge opportunities.

The reclaimed water alternatives are derived primarily from the results of these studies.

## **The Role of Conservation and Aquifer Protection**

Given previous findings of the aquifer's vulnerability to contamination and the limits of its ability to recharge, the project team assumed that the City's existing programs for ground-water protection and conservation would continue to be cornerstones of any future water strategy. For comparison purposes only, the team defined a "no-action" alternative that calls for continuing past practices of sole reliance on local ground water without conservation.

All alternatives except the "no-action" alternative started with the assumption that conservation goals would be successfully achieved on the timetable the City has established. The conservation goals require a 30 percent reduction in per capita water use by 2004.

The project team sought ways for water resource development, water conservation, and aquifer protection activities to reinforce each other. For example, public access and educational features at some of the recommended project facilities would focus on showing how water enters the aquifer and the dangers of contamination. The recommended rate study and new rate structure would focus on providing incentives for conservation and wise water use.

## **Using Strategy Tables to Explore Possibilities**

Strategy tables (Table 2-1 is an example table) were helpful tools in devising the alternatives. Strategy tables included the following components:

- The sources of water supply
- The method and location of diversion of San Juan-Chama and Rio Grande surface water
- The methods and area of use for San Juan-Chama water and recycled wastewater
- The timing or phasing of the implementation

Methods of use included various forms of aquifer recharge: direct use as part of the municipal water supply, localized or Citywide use, nonpotable uses such as irrigation, and maintenance of Rio Grande flows. Considering various combinations of these strategy elements prompted the project team to explore an extremely varied set of potential alternatives.

**TABLE 2-1**  
Strategy Table  
*The components of the prior management approach are highlighted*

Sources of Supply	Surface Water Diversion	Method of Use
Conservation	None	Direct use-drinking water
San Juan-Chama water	Existing Facilities	Nonpotable uses
Rio Grande		Citywide
		Southern golf courses
		North I-25 industrial
		Northern golf courses
		Inner valley irrigation
Ground Water	Infiltration Galleries	Recharge
Deep Aquifer		Injection wells
Shallow Aquifer		Arroyos
Relocated pumping		Spreading basins
		Inner valley
		Aquifer storage and recovery (ASR)
Reclaimed Water		Maintain Rio Grande Flows
Southside Water Reclamation Plant		
Localized Facilities		
Industrial-West Side		
Industrial-North I-25		

## The Alternatives Considered

The tables on the following pages list the 32 alternatives initially developed and evaluated. In general terms, the project team devised at least one alternative for each major method of implementing a given option. (For a more detailed discussion of the alternatives, refer to *Alternative Descriptions and Opinions of Cost*, CH2M HILL, 1997b).

As an example, alternatives for diversion and recharge of San Juan-Chama water include one each for the three primary methods for recharging water (injection wells, gravity flow through natural or constructed spreading basins, and aquifer storage/recovery wells). The diversion and recharge alternatives list also includes one alternative that employs infiltration galleries, another that adds some inner valley recharge enhancements, and one that includes a recreational riverwalk component. While time and budget constraints did not allow every combination of features to be tested separately, an extremely wide range of alternatives was taken into account.

## Ground-Water Development Alternatives

Table 2-2 summarizes strategies that rely entirely on ground water as the source of supply.

Alternative GW0 represents a “no-action” alternative. Alternatives GW1 and GW2 introduce conservation as a new “supply” source. For Alternative GW1 all new wellfields are located within the City’s existing service areas. Alternative GW2 would locate new wellfields in areas of the aquifer outside the City where severe aquifer mining has not yet occurred.

**TABLE 2-2**  
Ground-Water Development Alternatives

Alternative	Description	Explanation
GW0. Continued Current Trends	New wellfields and storage reservoirs, pump stations, and transmission lines are located within Albuquerque's water service areas	Base case assuming demands continue to increase at current trends
GW1. Continued Local Ground-Water Development, with Conservation	New wellfields and storage reservoirs, pump stations, and transmission lines are located within Albuquerque's water service areas	Local ground water is likely to be key to any future water resources strategy. This option describes the effects of complete reliance on local ground-water sources.
GW2. Relocation of Ground-Water Pumping	Construct a new wellfield and water transmission facilities outside the local water service area to deliver 47,000 ac-ft/yr (42 mgd) to Albuquerque	Slows the local declines of ground-water levels and increase river depletion, which could be offset by San Juan-Chama water

## **Diversion and Recharge Alternatives**

There are three primary methods for recharging water. Alternative DR1 recharges the aquifer with San Juan-Chama water through injection wells; then recharged water mixed with aquifer water is withdrawn through conventional production wells. Alternative DR2 uses a method known as aquifer storage and recovery (ASR), in which the wells used for recharge are the same ones used to pump the water back out of the ground. This alternative would use the MRGCD's Angostura Diversion Dam, located near Algodones, and their canal system to deliver river water to Albuquerque. Alternative DR3 recharges through the land surface using arroyo bottoms or spreading basins.

Alternative DR4 is similar to DR2, except that the surface water diversion consists of infiltration galleries near Albuquerque, instead of using the MRGCD's canal system. Alternative DR5 adds to DR3 some of the inner valley recharge enhancements suggested by the Bureau of Reclamation's *Water Assessment* and arroyo recharge through the Tijeras Arroyo. Alternative DR6 adds the recreational riverwalk component to Alternative DR5.

**TABLE 2-3**  
Diversion and Recharge Alternatives

Project	Description	Explanation
DR1. Injection of San Juan-Chama Water	Divert 47,000 ac-ft/yr of San Juan-Chama water from the Rio Grande using existing MRGCD facilities, treat to appropriate standards and inject into the aquifer	Puts San Juan-Chama water to use restoring ground-water levels to allow continued use of local ground water with fewer negative impacts
DR2. Aquifer Storage and Recovery of San Juan-Chama Water	Divert 47,000 ac-ft/yr of San Juan-Chama water from the Rio Grande with existing facilities and treat to drinking water standards; inject "excess" capacity to the aquifer using existing wells; recover stored water with wells to meet peak demands	Puts San Juan-Chama water to use restoring ground-water levels to allow continued use of local ground water with fewer negative impacts
DR3. Spreading Basins Recharge	Divert 47,000 ac-ft/yr of San Juan-Chama water from the Rio Grande near Albuquerque, pump to spreading basins for recharge	Puts San Juan-Chama water to early use; could restore ground-water levels to allow continued use of local ground water with fewer negative impacts
DR4. ASR/Infiltration	Divert 47,000 ac-ft/yr of San Juan-Chama water from the Rio Grande near Albuquerque using infiltration gallery, and treat to drinking water standards; inject "excess" capacity to the aquifer using existing wells; recover stored water with wells to meet peak demands	Puts San Juan-Chama water to use restoring ground-water levels to allow continued use of local ground water with fewer negative impacts; infiltration gallery potentially has less environmental impact and some treatment advantages
DR5. Enhanced Surface Recharge	Divert 47,000 ac-ft/yr of San Juan-Chama water using existing MRGCD facilities to transmit to treatment (filtration), then to spreading basins and Tijeras Arroyo; modify riverside drain check gates to enhance recharge, maintain winter flows in highline canal, interior drains	Effort to maximize surface recharge with modest structural components
DR6. Enhanced Surface Recharge and Recreation	Divert 47,000 ac-ft/yr of San Juan-Chama water using existing MRGCD facilities to transmit to treatment (filtration), then to spreading basins and Tijeras Arroyo; modify riverside drain check gates to enhance recharge, maintain winter flows in highline canal, interior drains, riverwalk	Same as DR5 (effort to maximize surface recharge with modest structural components) plus a recreational riverwalk component

## Diversion and Direct Use Alternatives

Five alternatives explore the direct use of San Juan-Chama water as part of the City's municipal water supply. Alternative DD1 diverts 47,000 acre-feet of San Juan-Chama water using infiltration galleries and distributes it throughout the City's service area.

Alternative DD2 is similar, but diversion occurs at existing MRGCD facilities. Alternative DD3 diverts twice as much water, thereby putting the full amount of the City's San Juan -Chama water to use. Twice as much water can be diverted because half will be returned to the river as treated effluent.

Alternative DD4 uses two 23,500 ac-ft/yr water treatment plants—one on each side of the Rio Grande—to avoid river crossings.

Alternative DD5 makes immediate use of the maximum amount of the City's renewable water resources. This includes calculation of twice the City's San Juan-Chama contract (since half returns to the river), plus increases in the return flow fraction of the City's water use expected to occur as outdoor consumptive uses are reduced and/or currently unaccounted for return flows are added to the calculation. Alternative DD5 thus diverts a total of 112,000 ac-ft/yr.

**TABLE 2-4**  
Diversion and Direct Use Alternatives

Project	Description	Explanation
DD1. Direct Use of San Juan-Chama Water	Divert 47,000 ac-ft/yr of San Juan-Chama water from the Rio Grande using infiltration galleries near Albuquerque, treat to drinking water standards, and supply areas throughout the City	Puts San Juan-Chama water to early use; reduces local pumping closing the gap between withdrawals and recharge
DD2. Direct Use of San Juan-Chama Water—MRGCD Delivery	Divert 47,000 ac-ft/yr of San Juan-Chama water from the Rio Grande using MRGCD facilities, treat to drinking water standards, and supply areas throughout the City	Similar to DD1, but potentially fewer new facilities required
DD3. Direct Use of San Juan-Chama and Rio Grande	Divert 94,000 ac-ft/yr (84 mgd) of San Juan-Chama and native water with local infiltration galleries, treat to drinking water standards, and supply citywide	Assumes 50% of the diversion (47,000 ac-ft/yr) is returned to river as treated effluent, consumptively using 47,000 ac-ft/yr
DD4. Direct use of San Juan-Chama (Modular Treatment)	Divert 47,000 ac-ft/yr of San Juan-Chama water from the Rio Grande using MRGCD facilities, treat to drinking water standards using two water treatment plants, one on each side of the river, and supply areas throughout the City	Similar to DD2, but would use two water treatment plants to avoid the need for river crossings
DD5. Maximize Surface Water Use	Divert 112,000 ac-ft/yr (100 mgd) of San Juan-Chama and native water with local infiltration galleries, treat to drinking water standards, and supply citywide	Assumes return flow calculations and existing water rights may allow diversion of greater amounts of surface water

## Reclaimed Wastewater Alternatives

Alternatives RW1 through RW3 are drawn from wastewater studies that the City's Wastewater Utility has recently conducted, including the *Reclamation and Recharge Feasibility Study* (see the appendices for an executive summary). These alternatives recharge reclaimed water (purified recycled wastewater) and are similar to Alternative DR1, except the source of water is recycled water instead of San Juan-Chama water.

All five RW alternatives are variations on this concept. Each differs in terms of how much reclaimed water would be used and where it would be injected into the aquifer. Work completed in 1996 considered reclamation and recharge of Intel's wastewater on the west side. The corresponding report estimates that Intel could recharge around 5,000 ac-ft/yr following proper treatment.

Alternative RW1 adds the west-side reclamation and recharge of about 5,000 ac-ft/yr of Intel's wastewater to the least costly of the original scenarios, which treat and recharge about 33,600 ac-ft/yr of effluent from the Southside Water Reclamation Plant.

RW2 and RW3 represent two of the more attractive variations from the original work without the Intel component.

Alternative RW4 considers direct use of reclaimed water for turf irrigation and/or industrial purposes for all large users citywide.

Alternative RW5 considers focusing nonpotable reuse on selected sites within the City, as opposed to RW4's citywide approach. Sites include:

- Southern public landscaping, parks and golf courses near the Southside Water Reclamation Plant (SWRP), including the University of New Mexico (UNM), Puerto del Sol, planned Isleta golf courses, and other small parks.
- Nonpotable reuse of industrial wastewater from Philips Semiconductor for the Balloon Fiesta Park and industrial uses in the North Interstate-25 industrial area.
- Nonpotable reuse of Intel's wastewater to meet west-side turf irrigation needs at Paradise Hills and Ladera golf courses and nearby parks.

Alternative RW6 is similar to RW5, but adds reuse for turf irrigation demands in the planned Mesa del Sol area south of the airport, including three parks and a golf course. It also includes constructed wetlands near the Southside Water Reclamation Plant to improve the quality of the existing SWRP effluent.

Alternative RW7 uses constructed wetlands to further improve the quality of all of the effluent from the Southside Water Reclamation Plant.

Alternative RW8 uses satellite wastewater reclamation facilities to divert wastewater on its way to the Southside Water Reclamation Plant and dedicates this water to nonpotable uses. Satellite treatment facilities located around the metropolitan area would serve major users such as the Ladera, Arroyo del Oso, Los Altos, and Tanoan golf courses.

**TABLE 2-5**  
Reclaimed Wastewater Alternatives

<b>Project</b>	<b>Description</b>	<b>Explanation</b>
RW1. Reclamation and Recharge—Southside Water Reclamation Plant and West Side	Inject 33,600 ac-ft/yr (30 mgd) into mid-injection zone; reclaim and recharge Intel's wastewater (5,000 ac-ft/yr or 4.6 mgd) on the west side	Uses treated effluent to maintain ground-water levels; minimizes NPDES compliance concerns; San Juan-Chama water used directly to offset reduced effluent discharge levels; amount of currently unencumbered San Juan-Chama water and west-side industrial component
RW2. Reclamation and Recharge—Zero Discharge (Scenario 2)	Inject 85,000 ac-ft/yr (76 mgd) into north and mid-injection zones	Option for using the full capacity of the Southside Water Reclamation Plant; distributes recharge over a wider area
RW3. Reclamation and Recharge (Scenario 3)	Inject 33,600 ac-ft/yr (30 mgd) into mid-injection zone	Amount of currently unencumbered San Juan-Chama water
RW4. Nonpotable Reuse—Citywide	Provide enhanced effluent treatment of 10,000 ac-ft/yr (9 mgd) and distribute through secondary water distribution to large turf and industrial users	Option for reusing wastewater at potentially lower costs than reclamation/recharge options as described above
RW5. Focused Nonpotable Reuse	Provide enhanced effluent treatment of about 1,800 ac-ft/yr and distribute through secondary water distribution to south area including golf courses, parks, and schools; provide enhanced effluent treatment of about 900 ac-ft/yr of industrial wastewater from the N. I-25 area for nonpotable uses nearby industrial reuse and landscape irrigation, including the Balloon Fiesta Park; provide reclamation of Intel's wastewater for irrigation on the west side	A more limited option for reusing wastewater, but focusing on more cost-effective components
RW6. Focused Nonpotable Reuse—Constructed Wetlands	Provide enhanced effluent treatment using constructed wetlands of about 3,900 ac-ft/yr and distribute through secondary water distribution to south area of City including golf courses, parks, and schools and Mesa del Sol; provide enhanced effluent treatment of about 900 ac-ft/yr of industrial wastewater from the N. I-25 area for nonpotable uses nearby, including the Balloon Fiesta Park; and provide reclamation of Intel's wastewater for irrigation on the west side	Similar to RW5, but uses constructed wetlands technology in lieu of tertiary filtration for the reclaimed water flow stream only
RW7. Constructed Wetlands	Provide a constructed wetlands (approx. 560 acres) to polish the waste-water treatment effluent prior to discharge. In addition, a constructed wetlands at the north and south discharge points of the AMAFCA canals would capture dry weather flows and also minimize nonpoint pollution	Wetlands have the potential to enhance the quality of the discharged reclaimed water and enhance wildlife habitat; wetlands could provide similar benefits associated with recharge of stormwater flows
RW8. Distributed Wastewater Treatment Facilities for Reclamation	Construct small wastewater treatment plants at strategic locations for the purpose of providing reclaimed water for the following golf courses: Ladera, Arroyo del Oso, and Los Altos, in addition, the Southside Water Reclamation Plant will provide reclaimed water for irrigation at the south area of the City, including Mesa del Sol, and provide enhanced effluent treatment of about 900 ac-ft/yr of industrial wastewater from the N. I-25 area for nonpotable uses nearby, including the Balloon Fiesta Park	Small, localized wastewater treatment plants could avoid the costs of pumping reclaimed water to users far removed from the Southside Water Reclamation Plant

## Multicomponent Alternatives

Multicomponent alternatives are those that combine attractive features of more than one basic approach.

Alternative MC1 combines the direct use elements of Alternative DD3 with ASR aspects similar to Alternative DR2. MC1 recharges the aquifer in the Volcano Cliffs, College, and Freeway service areas. It includes the North I-25 and southern nonpotable reuse components from Alternative RW5. It also includes inner valley recharge enhancements to allow the use of shallow ground water to supply Tanoan, Arroyo del Oso, and Albuquerque Country Club golf courses and various parks, including the zoo and botanical gardens.

Alternative MC2 adds only the localized nonpotable reuse components to Alternative DD3.

Alternatives MC3 and MC4 add nonpotable uses of surface water and shallow ground water (respectively) to DD3. Irrigation demands of residential, commercial, and industrial users near existing canals and ditches that are now met using the City's deep ground water would be supplied from either surface water (MC3), or from shallow ground water (MC4). Alternative MC4 includes enhanced recharge components to make shallow ground-water use sustainable.

Alternative MC5 is similar to Alternative MC1, but does not include the shallow ground-water component.

Alternative MC6 addresses the problem of contaminated ground water on the west side. It is similar to Alternative DD3, but includes a pump-and-treat system to purify the contaminated ground water and a compatible recharge system. MC6 is based on an estimated pumping rate of about 2,000 gallons per minute (gpm) or about 3,200 ac-ft/yr. The full extent of the contamination is not known, but MC6 would provide a capture width of about 2,400 feet through about 200 feet of aquifer thickness. Inclusion of the Calabacillas Arroyo recharge component would augment the capture by causing a downstream hydraulic barrier to flow.

Alternative MC7 uses constructed wetlands to accomplish the Southside Water Reclamation Plant effluent treatment for the reuse components of Alternative MC2.

Alternative MC8 adds valley recharge enhancements to the direct use components of Alternative DD3.

Alternative MC9 is similar to MC7, but the North I-25 recycling component is augmented with a small infiltration gallery to add use of nonpotable surface water. MC9 includes a small shallow ground-water component, with associated enhanced recharge, to meet some irrigation demands in inner valley areas including the zoo, botanical gardens, and the Albuquerque Country Club. MC9 also includes a small ASR demonstration project at two to three wellfields.

Alternative MC10 combines arroyo recharge at Calabacillas Arroyo with the large-volume diversion and direct use project of DD3.

**TABLE 2-6**  
Multicomponent Alternatives

<b>Project</b>	<b>Description</b>	<b>Explanation</b>
MC1. Direct Use with ASR, Valley Recharge Enhancements and Modified Nonpotable Reuse	Divert for direct use and ASR 94,000 ac-ft/yr using existing facilities; reuse about 3,900 ac-ft/yr for southern parks and golf courses and about 900 ac-ft/yr for industrial reuse (NE Heights), and work with MRGCD to implement valley recharge enhancements	Combines direct use features of DR2 and DD3 with more cost-effective nonpotable reuse option
MC2. Direct Use and Modified Nonpotable Reuse	Divert 94,000 ac-ft/yr of San Juan-Chama and Rio Grande water from the Rio Grande using infiltration galleries near Albuquerque, treat to drinking water standards, and supply areas throughout the City; reuse about 3,900 ac-ft/yr for south City turf uses and Mesa del Sol, and about 900 ac-ft/yr for industrial reuse in the north I-25 corridor	Combines direct use features of DD3 with modified nonpotable aspects of MC1
MC3. Direct Use of San Juan-Chama, Nonpotable Surface Water	Divert 94,000 ac-ft/yr of San Juan-Chama and Rio Grande water from the Rio Grande using MRGCD facilities, treat to drinking water standards, and supply areas throughout the City; divert an additional 2,100 ac-ft/yr and provide for nonpotable uses	Direct use as in DD3; nonpotable use of surface water reduces treatment needs offsets demands on higher quality deep aquifer
MC4. Direct Use of San Juan-Chama, Shallow Ground Water for Nonpotable Uses	Divert 94,000 ac-ft/yr of San Juan-Chama and Rio Grande water from the Rio Grande using MRGCD facilities, treat to drinking water standards, and supply areas throughout the City; produce about 6,000 ac-ft/yr of shallow ground water and provide for nonpotable uses	Direct use as in DD3; nonpotable use of poorer quality ground water offsets demands on higher quality aquifer as in MC3, but shallow ground-water system becomes the "distribution" system allowing a greater feasible service area
MC5. Direct Use of San Juan-Chama, ASR, Modified Nonpotable Reuse	Divert 94,000 ac-ft/yr of San Juan-Chama water from the Rio Grande using infiltration galleries near Albuquerque, treat to drinking water standards, and supply areas throughout the City; include capacity for diversion (and aquifer storage) of up to an additional 47,000 ac-ft; reuse about 3,900 ac-ft/yr for south City turf needs and about 900 ac-ft/yr for industrial reuse	Similar to MC1, but without the shallow ground-water component
MC6. Direct Use of San Juan-Chama, West-Side Recharge and Remediation	Divert 94,000 ac-ft/yr of San Juan-Chama and Rio Grande water from the Rio Grande using MRGCD facilities, treat to drinking water standards, and supply areas throughout the City; integrate a pump-and-treat system for Coors Road ground-water contamination into west-side supply needs; divert and recharge through the Calabacillas Arroyo recharge window about 7,800 ac-ft/yr of surface water	Add components designed to deal with west-side contamination and aquifer drawdowns to direct use Alt. DD3
MC7. Direct Use and Focused Nonpotable Reuse with Constructed Wetlands	Divert 94,000 ac-ft/yr of San Juan-Chama and Rio Grande water from the Rio Grande using infiltration galleries near Albuquerque, treat to drinking water standards, and supply areas throughout the City; treat (with constructed wetlands) and reuse for southern turf needs and industrial reuse	Same as MC2, but constructed wetlands are used to treat SWRP effluent

**TABLE 2-6**  
Multicomponent Alternatives

<b>Project</b>	<b>Description</b>	<b>Explanation</b>
MC8: Direct Use of San Juan-Chama with Recharge	Divert 112,000 ac-ft/yr of San Juan-Chama and Rio Grande water from the Rio Grande using MRGCD facilities, treat 103,000 ac-ft/yr to drinking water standards, and supply areas throughout the City; work with MRGCD to enhance valley recharge	Adds enhanced valley recharge component to direct use alternative DD5
MC9: Direct Use and Focused Nonpotable Reuse with Constructed Wetlands, ASR, Shallow Ground Water and Surface Water for Nonpotable Irrigation	Divert 97,000 ac-ft/yr of San Juan-Chama and Rio Grande water from the Rio Grande using infiltration galleries, treat 94,000 ac-ft/yr to drinking water standards, and supply areas throughout the City; retrofit 2 or 3 wellfields with ASR capability; work with MRGCD to enhance valley recharge (about 900 ac-ft/yr); treat (with constructed wetlands), reuse for southern turf needs and industrial reuse in north, combined with about 1,900 ac-ft/yr of surface water	Small-project components are potentially more flexible and effective; ASR is included, but not a mainstay
MC10: Direct Use of San Juan-Chama and Calabacillas Arroyo Recharge	Divert 94,000 ac-ft/yr of San Juan-Chama and Rio Grande water from the Rio Grande using infiltration galleries, treat to drinking water standards, and supply areas throughout the City; divert and recharge through the Calabacillas Arroyo recharge window about 7,800 ac-ft/yr of surface water	Calabacillas Arroyo is potentially the best surface recharge opportunity

The 32 alternatives described above were evaluated using the criteria and measures of performance discussed in the following chapter.

# Chapter 3

## Criteria and Measures of Performance

### Devising Appropriate Criteria

Perhaps no task is more difficult than capturing in a few measurable criteria the factors that will determine which water strategy is “best”. This aspect of project work drew on numerous discussions with the general public, community interest groups, federal and state regulatory and water agency officials, people from neighboring jurisdictions, ratepayer surveys and feedback, and interaction with City staff and elected officials. (See Appendix E for a summary of project public involvement activities.) The 10-member Customers Advisory Committee and the City Staff Steering Committee comprised of participants from the City Council staff and several City departments reviewed and discussed this aspect of the project in detail.

Public input included specific discussion of the proposed criteria at two public forums attended by more than 150 people. Forum participants were asked to comment on proposed criteria and to suggest additional criteria on feedback forms. The criteria used to evaluate the alternatives reflect the comprehensive public involvement efforts made in the course of the Water Resources Management Strategy project.

The project team took a common-sense approach that sought criteria meaningful to any interested party. The goal was to find criteria that were:

- Comprehensive, covering all major issues
- Fundamental, dealing with the essential reasons for action
- Relevant in distinguishing among alternatives
- Well defined and understandable
- Nonredundant; that is, did not cause some factors to be double counted
- Independent, so that impacts for different objectives could be measured

Safeguarding public health and safety was established at the outset as an essential characteristic of any alternative. No practice or technology that threatens to compromise health or safety is included in the list of potential alternatives. Public health and safety issues are not discussed in the remainder of this report because all alternatives meet this criterion.

### Measures of Performance

Once a criterion is accepted as meeting the 6-part test outlined above, means of determining how well an alternative will meet that criterion must be devised. This report refers to these as measures of performance.

The project team maintained a dialog on the relevance and acceptability of various measures of performance in interviews and meetings with the full range of stakeholders involved. The final measures agreed upon reflect the interests expressed in this dialog.

For example, in determining how to measure environmental impacts, discussion brought to the fore the list of resources that needed to be taken into account. Potential impacts on the bosque, the river, endangered species, agricultural lands, and recreation areas, among

other resources, were important to many stakeholders. Protection of the aquifer and assuring its ability to continue as a safe and reliable water source were at the top of the priority list for virtually all stakeholders, regardless of their technical or ideological orientation.

## Agreed Upon Criteria and Measures of Performance

Five fundamental criteria formed the basis for evaluation: environmental protection, sustainability and reliability, implementability, the quality of life in New Mexico, and financial support. Figure 3-1 shows these objectives and the elements that provided the focus for measuring performance on each. The following pages discuss each criterion and the corresponding scale of measurement used.

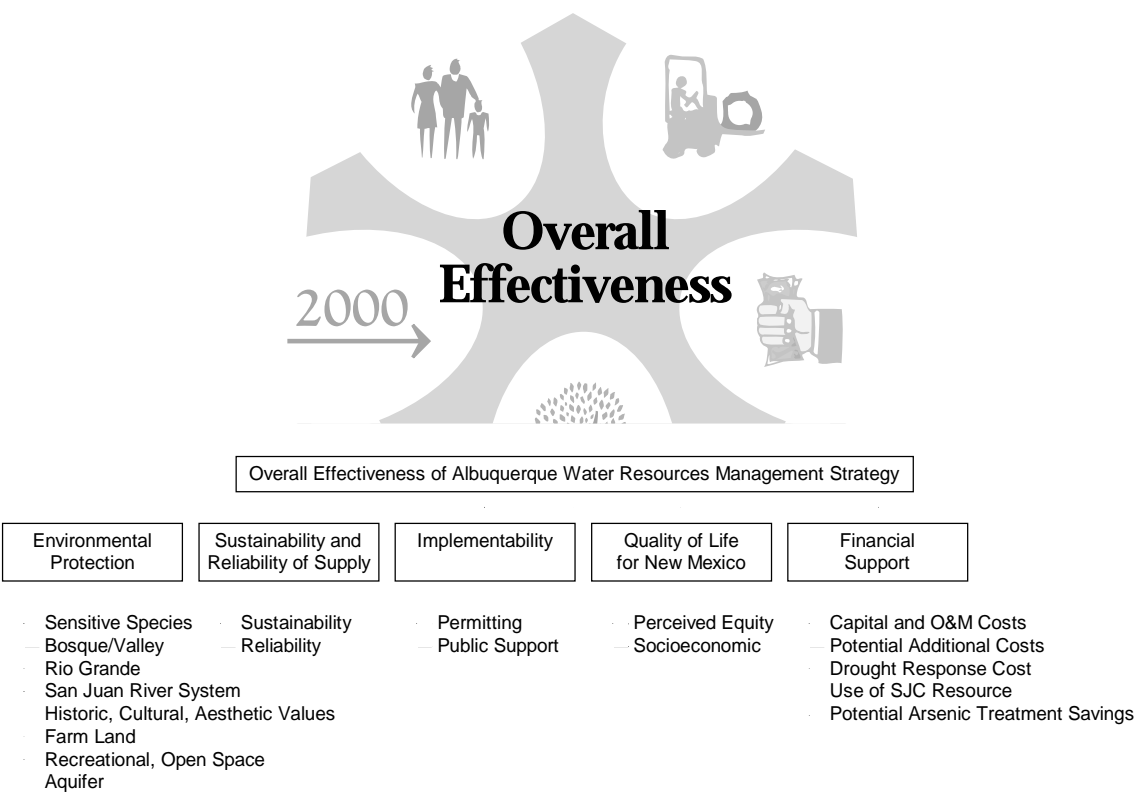


Figure Chapter 3 -1. Evaluation Criteria

## Environmental Protection

The effect of implementing each alternative on the environment was considered one of the fundamental aspects to be evaluated. This objective takes into account physical effects, but does not consider impacts related to regulatory violations, fines or penalties, which are considered under the financial support criterion.

Based on the input received, the project team first listed the environmental resources that merited focused consideration. These include:

- Population or habitat of a sensitive wildlife species (e.g., Rio Grande silvery minnow, Southwest willow flycatcher)
- The bosque/inner valley
- The Rio Grande (including water quantity and quality)
- The San Juan River system tributaries (including water quantity and quality)
- Sites or areas of historic, cultural, or aesthetic value
- Farm lands
- Other land of special use (recreational area—e.g., Heron and Abiquiu Reservoirs, open space)
- The aquifer (ground-water quality, quantity, and subsidence impacts)

The project team estimated the severity of environmental effects on each of these resources, taking into consideration the amount of water impacted by each alternative, the location(s) at which resources would be affected, and ways they could be affected.

The scale of measurement consisted of a rating from 1 to 5, with 1 being the most positive and 5 the most negative. To receive a score of 1, the alternative would have to create a small to moderate positive effect on the resource in question. A score of 5 indicates the alternative could cause severe, widespread permanent damage. Intermediate scores indicate no effect, small and quickly reversible effects, or moderate effects that would be self-correcting over time.

A key aid in this assessment was the work completed in the development of the *Bosque Management Plan* (Crawford and others, 1993). Drawing on that work, the analyses considered the following:

- In-stream flow changes and associated biological effects on San Juan River system tributaries
- In-stream flow changes and associated biological effects on the Rio Grande
- The extent to which flow changes on the Rio Grande diverge from the natural hydrograph relative to current conditions
- The extent to which a perennial flow is provided in the Rio Grande and Rio Chama
- Effects of fragmentation of the bosque system riparian and wetland communities
- Potential direct effects on wetland and riparian communities in the bosque
- Potential for enhancement or creation of wetlands and riparian communities outside of the bosque

- Potential for enhancement or creation of wetlands and riparian communities inside of the bosque
- Potential reservoir operational changes and effects on recreation and biotic communities
- Potential effects on native upland communities
- Potential to improve the bosque by increasing duration and/or frequency of flooding in the bosque

## **Implementability**

This objective addresses the degree of difficulty involved in designing, building, and operating an alternative. While it takes operating complexities into account, technical difficulty was not considered a major concern, since all alternatives apply only proven technology. The project team foresees two areas of potential difficulty that were carefully considered:

- Permitting difficulties related to technical issues or aspects of the project that would cause difficulties in obtaining necessary backing from state and federal agencies
- Public perceptions leading to concerns with the design, location, water quality, or supply source; or public perceptions leading to concerns with the impact on water rates

With both of these factors in mind, performance measures called for a score of 1 for alternatives for which implementability problems would have no noticeable impact to the project schedule, budget, or overall technical plans, and for which public support was evident among some constituencies. The lowest score, a 5, was assigned if implementability problems were likely to cause delays of 6 to 10 years or if the ultimate implementation of the project(s) would be in doubt.

Problems resulting in delays of 1 to 2 years that did not cause a major disruption in project implementation were considered to indicate a low severity of impact, while probable delays of 4 to 6 years were considered to have a relatively high severity of impact.

## **Sustainability and Reliability Of Supply**

This criterion relates to how renewable the proposed water supply is and whether the supply is subject to short- or long-term interruptions due to water quality problems or natural adversities such as a prolonged drought. "Renewable" is defined as available in perpetuity.

Because all alternatives include the use of ground water, the system's ability to deal with short-term problems would be good regardless of the alternative selected. The distinguishing aspect of this criterion is the ability to withstand periods of prolonged drought, when surface water supplies (which are renewable) might be unavailable for long periods.

The *Value of Water* study (see Appendix B) defines the concept of a ground-water drought reserve (see Figure 3-2). The study estimates that to provide supplies during a 10-year drought similar to the drought of record (the worst that has occurred in the past) near the end of the planning period, a ground-water reserve of about 2 million acre-feet is needed. The project team considered that this amount would need to be pumped without drawing the aquifer down to levels that would cause land subsidence in widespread areas.

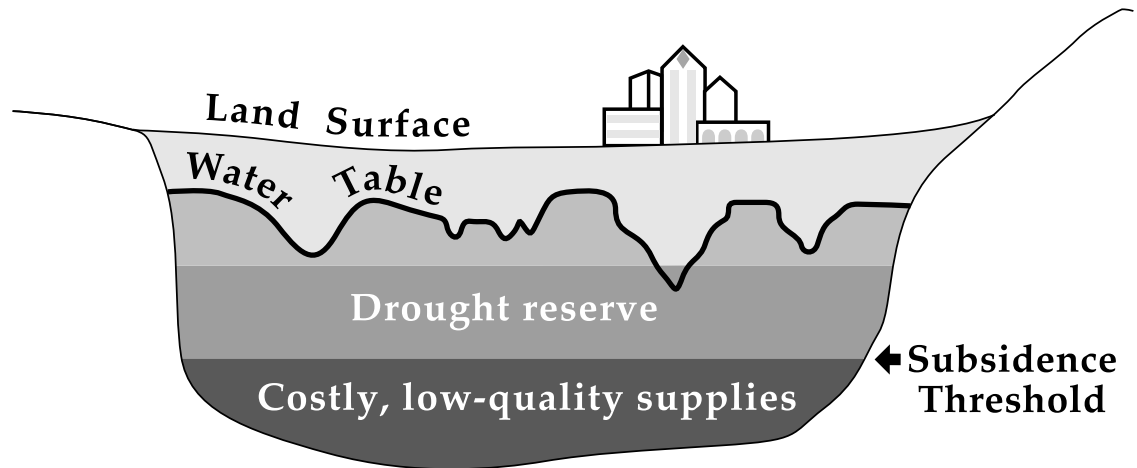


Figure Chapter 3 -2. The Aquifer as a Drought Reserve

Reliability is therefore measured as the ability to maintain a drought reserve intact

throughout the planning period. The scores range from a “1” if the drought reserve and a margin of safety that allows for some miscalculation of the exact level of drawdown that would cause widespread subsidence is maintained, to a “5” if the drought reserve is completely depleted by the end of the planning period (the year 2060). A score of “1” means no interruptions of supply would be necessary, while a “5” implies that during a prolonged drought even basic water services might have to be curtailed.

The costs of coping with prolonged drought in the absence of an adequate ground-water reserve are not considered under this criterion. All costs are considered under the criterion of financial support.

Sustainability was measured by the degree to which the alternative provided renewable supplies through 2020. A score of 1 indicates 100 percent of the supply was renewable, while a 5 indicates that less than 25 percent of the supply consists of renewable resources. Note that none of the alternatives provides a renewable supply to 2060; additional supplies will be needed to maintain sustainability after 2020, regardless of the alternative chosen for implementation.

## Support for the Quality of Life In New Mexico

This objective addresses the degree to which an alternative supports socioeconomic benefits, is perceived to be equitable in the distribution of costs (including nonfinancial costs) and benefits, and avoids disrupting normal public activity. The region, and especially the City’s service area, are considered.

Socioeconomic benefits include assurance of the City's ability to contribute to maintenance of a healthy local economy by providing service to new and existing water customers. They also include amenities such as irrigated park lands, public landscaping, greenbelts and golf courses.

Socioeconomic benefits are measured by the degree to which the City would be able to assure no curtailment or denial of basic water infrastructure needed to support normal industrial and residential growth. A second measure is the ability to supply or need to curtail water supplies for parks and other amenities.

Equity is often in the eye of the beholder, but some basic elements of fairness can be determined and public perception of others is evident. For example, if current generations use low-cost ground-water supplies to the extent that there are none left for the future, a basic generational inequity occurs. Or, if perceived or actual negative impacts of a project fall primarily on one group, while the perceived or actual benefits accrue to another, the strategy may be considered inequitable.

The project team used public protest and negative media coverage on equity issues as measures of perceived equity. While virtually no public project is executed without some objections being raised, major public outcry and organized opposition based on equity issues are clear indicators. A score of 1 was assigned to alternatives that were considered likely to generate little protest and to receive at least some community support on equity issues. The scale for this criteria went from 1 to 6, with scores of 5 and 6 assigned when equity issues were considered not only to be "perceived", but were also documentable. A score of 6 indicates that the alternative presents inequities that are so serious as to make implementation unlikely.

## **Financial Support**

This criteria gathers together all the potential financial costs generated by the alternatives and identifies the lowest cost alternatives. Costs included under this heading are:

- Capital required to design, build, and operate facilities and programs, calculated on a net present worth basis for a 20-year period beginning with project implementation.
- Additional costs for environmental mitigation, payment of regulatory fines or penalties, and maintaining systems in the face of abnormal conditions.
- Expenses related to responding to drought conditions, assuming the occurrence of a drought late in the planning period. Calculation was based first on the availability of a drought reserve. If the alternative led to a depleted drought reserve, then curtailment of service to parks and golf courses was assumed to occur first, followed by curtailment of residential irrigation. Calculations took into account necessary reseeding of turf and landscape areas. The project team also assumed that the aquifer would be used to provide needed supplies, even if this led to land subsidence. This implies additional pumping costs, plus the costs of subsidence in the form of damage to buildings and infrastructure. Subsidence cost estimates were based on the geographic extension of subsidence likely to occur for a given amount of pumping below the subsidence threshold. The estimates were discounted based on net present worth calculations and on the probability of the occurrence of a severe drought late in the planning period. This probability was calculated on the basis of the historic gaging records at the Otowi gage.
- The benefit or credit gained or lost related to utilization of San Juan-Chama water. The project team calculated the credit in net present worth (NPW) terms based on the percentage use of the City's San Juan-Chama water times the City's average annual

obligation of about \$2 million per year for participation in the San Juan-Chama project.

- Potential arsenic treatment costs incurred owing to a combination of stricter regulatory standards and higher arsenic concentrations in water pumped from deeper in the aquifer. Thus, the amount an alternative relied on water pumped from deeper in the aquifer was a factor, as was a calculation of the probability that future regulatory standards for arsenic would be set at 20 parts per billion (ppb) versus 5 ppb. The probability of no change in regulatory standards was estimated at 10 percent, the probability of a 20-ppb standard was estimated at 40 percent, and the probability of a 5-ppb standard at 50 percent.

The scores for this criteria were assigned on the basis of total expected cost impact of the project, considering the projects direct costs and the indirect costs identified above.

The results of applying these criteria and measures of performance to 32 alternatives are covered in Chapter 4. For a more detailed discussion of the criteria definitions and scales of measurement used, see CH2M HILL (1997a).



# Chapter 4

## Preliminary Evaluation

Once the alternatives, criteria and measures of performance were in place, the project team was ready to score the alternatives and produce evaluation results.

### Methods and Data Sources

The evaluation process used rigorous decision analysis techniques that involved complex calculations of utility functions and took probabilities of uncertain events into account. Refer to the chapters covering evaluation in *Evaluation of Alternatives and Strategy Formulation: Technical Basis of the Recommended Strategy* (CH2M HILL, 1997a) for an explanation of how these mathematical concepts were applied.

Data used as the basis for scoring came from many different sources, including the technical reports and studies mentioned earlier in this Summary Report. Additional sources included environmental studies conducted as part of Phase 2 that investigated ground-water recharge and river flow effects. The project team also developed cost estimates for each alternative.

Water demand projections developed in Phase 1 of the Water Resources Management Strategy continued to be used. Except for the base case alternative that estimated the effects of continuing current practices without conservation, all evaluation assumed that City would meet its 30 percent per capita conservation goals on schedule.

The 1995 USGS model of the aquifer was used in calculating the amount of aquifer drawdown each alternative was likely to cause. The amount of reduction in streamflow in the Rio Grande caused by the City's pumping also was calculated using the USGS model, even though under the current administrative regime this is not the standard.

The project team used the USGS model because we believe it to be the most accurate means available for estimating the functioning of the aquifer. The State Engineer—New Mexico's chief water regulator—is currently evaluating the USGS model and has stated that further study is needed to confirm its validity before changes in water administration are made. City discussions with the State Engineer and other experts indicate, however, that the model is widely accepted as a vast improvement over past methods of estimating aquifer recharge and other hydrogeologic phenomena, even though some unknowns remain.

Professional judgment of course played a role in many scoring decisions. Especially in estimating the degree of difficulty with permitting or potential public reaction, no substitute was found for simple estimations based on knowledge of regulatory practices and feedback received from regulators, community leaders and the public during the activities that were conducted as part of Phase 2.

Hands-on participation of the City Staff Steering Committee in the scoring process and detailed review by the Customers Advisory Committee provided "reality checks" for the project team. In addition, more than 150 area residents attended public forums held to review preliminary evaluation results. They were asked to complete feedback forms to provide the project team with their views of the preliminary results. They reported no substantive disagreement with the scoring, although the priorities they placed on different criteria were varied. Many people also pointed out the importance of regional approaches that take into account the fact that the aquifer is a resource shared by many users.

While the project team recognizes that no two evaluators would assign exactly the same scores to all alternatives, we are confident that the evaluation is a valid means of sorting the best alternatives from among the options. Although minor individual scoring differences did occur, they were not large enough to affect the overall findings.

The following pages summarize the results of applying the criteria to the 32 alternatives. How alternatives scored on individual criteria is covered in detail. As described in the previous chapter, most scoring was done on a scale of 1 to 5, or in some cases, 1 to 6. The lower the score, the more favorable the evaluation; that is, a “1” is the best score in the tables that follow.

Please refer to the tables in Chapter 2 for descriptions of the alternatives, which are indicated below by their abbreviated names or to Appendix F, which contains a fold-out table summarizing the alternatives. For simplicity, note that:

- “GW” alternatives call for the use of ground water only.
- “DD” alternatives involve the diversion and direct use of San Juan-Chama water in the municipal water supply.
- “DR” alternatives divert San Juan-Chama water and use it to recharge the aquifer.
- “RW” alternatives recycle wastewater for either nonpotable use or aquifer recharge.
- “MC” alternatives combine projects of different types.

## **Scoring of Alternatives by Criterion**

### **Environmental Protection Evaluation**

As explained in Chapter 3, the environmental protection criterion looked at the impact of each alternative on several different critical environmental resources, which are listed separately below. A preliminary evaluation of environmental effects was completed by the project team (CH2M HILL, 1997c). No evaluation was made of impacts on farm lands or sites of historic, cultural, or aesthetic value, because these impacts are site-specific. Once potential sites are identified, this element of the evaluation can be carried out.

Each resource accounted for a percentage of the overall environmental protection score, with sensitive wildlife species, the bosque/inner valley, and the aquifer accounting for 20 percent each; the Rio Grande and the San Juan River system accounting for 15 percent each; and recreational and other special-use lands accounting for 10 percent.

#### **Population or Habitat of a Sensitive Wildlife Species**

All of the alternatives have minor (less-than-moderate) effects on the habitat of the endangered Rio Grande silvery minnow and Southwest willow flycatcher.

No significant effects on their habitat are anticipated for the ground-water alternatives, the diversion and recharge (DR) alternatives, the 47,000 ac-ft/yr diversion and direct use alternatives, and the reclaimed water (RW) alternatives. These diversion and recharge and diversion and direct use alternatives would divert only San Juan-Chama water (47,000 ac-ft/yr), which would be imported into the Rio Grande.

The direct use alternatives that divert greater amounts of water (DD3 and DD5) and the multicomponent (MC) alternatives, which also divert greater amounts, would have a small effect on silvery minnow habitat, because there would be a slight depletion of river

flows between the diversion and return flow points. However, these alternatives are designed to allow reliance on ground-water pumping during periods of very low flow, so that the City would not cause the river to “dry up”. Thus, these effects are minor, temporary, and self-correcting to an extent over time.

Score	Severity of Environmental Effects on Habitat and Populations of Sensitive Species	Alternatives
2.	There is essentially <i>no effect</i> on the environment.	GW0, GW1, GW2 DR1, DR2, DR3, DR4, DR5, DR6 DD1, DD2, DD4, RW1, RW2, RW3, RW4, RW5, RW6, RW7, RW8
3.	There is a <i>small effect</i> on the environment; there is no credible scenario that includes significant damage. At worst, there will be a minor and temporary impact that is essentially self-correcting.	DD3, DD5 MC1, MC2, MC3, MC4, MC5, MC6, MC7, MC8, MC9, MC10

### The Bosque and the Inner Valley

The alternatives affect the bosque and inner valley area in a manner similar to the effects on the silvery minnow habitat described above.

Some improvement might be expected due to habitat improvements associated with some of the enhanced valley recharge alternatives (DR5 and DR6). The large constructed wetlands alternative (RW7) would produce localized improvements, but these would be offset somewhat by potential damage to plants requiring high ground-water levels, because large ground-water level declines accompany this alternative.

Limited habitat improvement for other surface water recharge alternatives (DR1 through DR4) may occur, although operational constraints limit the benefits. In addition, for DD3, DD5, and the multicomponent (MC) alternatives, river pipeline crossings would also cause minor temporary effects for the diversion and direct use (DD) alternatives.

No net effects are anticipated for the other diversion and recharge (DR) and larger reclaimed water (RW) alternatives, although some minor temporary construction effects related to installation of infiltration galleries to divert surface water would occur with alternatives DR3 and DR4. Alternatives DR1, DR2, and DD4 rely on existing structures for diversion of surface water and require no river crossings.

The alternatives that rely solely on local ground water (GW0 and GW1) and the similar low-volume reclaimed water alternatives (RW4 through RW8) have the greatest potential to adversely impact the bosque and inner valley habitat, because they would cause the greatest decline in ground-water levels within the valley.

Level	Severity of Environmental Effects on the Bosque and Valley	Alternatives
1.	There is a <i>small to moderate positive effect</i> on the environment.	
1.5	Intermediate between Levels 1 and 2.	DR5, DR6
2.	There is essentially <i>no effect</i> on the environment.	GW2 DR1, DR2 DD4 RW1, RW2, RW3, RW7
2.5	Intermediate between Levels 2 and 3	DR3, DR4
3.	There is a <i>small effect</i> on the environment; there is no credible scenario that includes significant damage. At worst, there will be a minor and temporary impact that is essentially self-correcting.	DD1, DD2, DD3, DD5 MC1, MC2, MC3, MC4, MC5, MC6, MC7, MC8, MC9, MC10
4.	There is a <i>moderate effect</i> on the environment; there are credible scenarios that include reductions in the local abundance or quality of a sensitive resource. There may be some impacts over time, but they will be self-correcting to an extent over time.	GW0, GW1 RW4, RW5, RW6, RW8

### The Rio Grande

The ground-water-only (GW) alternatives and the small-volume reclaimed water alternatives (RW4, RW5, RW6 and RW8) would have no impacts on the Rio Grande system.

The DR alternatives and DD1, DD2, and DD4 would cause minor positive effects, because flows in the Rio Grande upstream of the diversion would be augmented by about 65 cubic feet per second (cfs).

Small, minor, and temporary effects are anticipated for the larger-volume diversion alternatives (DD3, DD5, and MC1 through MC8), which would cause a minor reduction in flows between the diversion point and the Southside Water Reclamation Plant return flow point. These alternatives would not cause flow reduction during very low-flow periods caused by drought because diversion of Rio Grande would be temporarily halted and ground water would be used as the source of supply.

Score	Severity of Environmental Effects on the Rio Grande	Alternatives
1.	There is a <i>small to moderate positive effect</i> on the environment.	DR1, DR2, DR3, DR4, DR5, DR6 DD1, DD2, DD4, RW1, RW2, RW3, RW7
2.	There is essentially <i>no effect</i> on the environment.	GW0, GW1, GW2 RW4, RW5, RW6, RW8
3.	There is a <i>small effect</i> on the environment; there is no credible scenario that includes significant damage. At worst, there will be a minor and temporary impact that is essentially self-correcting.	DD3, DD5 MC1, MC2, MC3, MC4, MC5, MC6, MC7, MC8, MC9, MC10

### The San Juan River System

None of the alternatives impact the San Juan River system, because conditions there would remain very similar to those at present. The City has almost always taken full delivery of its San Juan-Chama water from the San Juan basin since the early 1980s. None of the alternatives would require a greater diversion of water from the San Juan than that already taking place.

### Recreational and Open Space

Alternatives that utilize San Juan-Chama water have moderate effects on water levels in Heron and Abiquiu Reservoirs. These effects will include the periodic lowering of water levels in Heron Reservoir, which would not be more significant than those already contemplated by the USBR to meet project firm yield calculations. These reductions would probably be temporary, but in any event are not directly attributable to City alternatives, but to the original San Juan-Chama Diversion Project.

The effects on water levels in Abiquiu Reservoir will depend on the degree to which others elect to store water there. Much of the water currently stored in Abiquiu is City of Albuquerque San Juan-Chama water.

Score	Severity of Environmental Effects on Other Lands and Recreation	Alternatives
2.	There is essentially <i>no effect</i> on the environment.	GW1, GW2 RW4, RW5
3.	There is a <i>small effect</i> on the environment; there is no credible scenario that includes significant damage. At worst, there will be a minor and temporary impact that is essentially self-correcting.	GW0 RW1, RW2, RW3, RW6, RW7, RW8
4.	There is a <i>moderate effect</i> on the environment; there are credible scenarios that include reductions in the local abundance or quality of a sensitive resource. There may be some impacts over time, but they will be self-correcting to an extent over time.	DR1, DR2, DR3, DR4, DR5, DR6 DD1, DD2, DD3, DD4, DD5 MC1, MC2, MC3, MC4, MC5, MC6, MC7, MC8, MC9, MC10

### The Aquifer

The alternatives that rely most heavily on ground water have the greatest potential for adverse aquifer effects, including land-surface subsidence (with the attendant irreversible loss of aquifer storage) and diminishing water quality. The aerial extent over which the subsidence threshold (estimated at 260 feet of total drawdown) is exceeded is taken as the best measure of potential aquifer effects.

Alternatives GW0, GW1, and RW7 would lead to a major effect on the aquifer, with the aerial extent of subsidence exceeding 20 square miles (and greater than 200 square miles for GW0).

Score	Severity of Environmental Effects on the Aquifer	Alternatives
2.	There is essentially <i>no effect</i> on the environment.	DD3, DD5 MC1, MC2, MC3, MC4, MC5, MC6, MC7, MC8, MC9, MC10
3.	There is a <i>small effect</i> on the environment; there is no credible scenario that includes significant damage. At worst, there will be a minor and temporary impact that is essentially self-correcting.	GW2 DR2, DR4 DD1, DD2, DD4 RW2
4.	There is a <i>moderate effect</i> on the environment; there are credible scenarios that include reductions in the local abundance or quality of a sensitive resource. There may be some impacts over time, but they will be self-correcting to an extent over time.	DR1, DR3, DR5, DR6 RW1, RW3, RW4, RW5, RW6, RW8
5.	There is a <i>major effect</i> on the environment; there are credible scenarios that include widespread and severe damage to sensitive resources. Quality of resources will decline rapidly over time; there will be some permanent and irreparable damage to these resources.	GW0, GW1 RW7

## Implementability Evaluation

The implementability criterion addresses the potential difficulty of gaining approval for, executing and operating the projects involved in each alternative. No commentary appears below on the design or operational difficulty of the alternatives because all use proven and practical technology. The two areas that are addressed are the difficulty of obtaining required permits and the degree of public support that is likely.

These two elements were combined to create an overall score for implementability by assuming that the more negatively scored element would set the score for the category. For example, if an alternative received a score of 4 for permitting difficulty and a score of 2 for public support, its overall implementability score would be 4.

### Permitting and Technical Issues

The project team believes that several of the alternatives have very severe permitting difficulties, to the extent that ultimate implementation of the alternative is threatened. These include the ground-water-only alternatives (GW0, GW1, and GW2), because they appear so contrary to State Engineer Office guidelines related to public welfare and impairment; and the low-volume reclaimed water alternatives (RW4, RW5, RW6, RW7, and RW8), because they are so close in effect to GW1.

Only marginally better are recharge alternatives DR5, DR6, and the zero-discharge reclaimed water alternative RW2. Alternatives DR 5 and DR6 are expected to be difficult to permit because, in addition to the ambiguity involving ownership of recharge water in New Mexico, they would require resolving siting issues and cooperative agreements among a number of jurisdictions, including the federal government, Pueblo of Sandia, and the MRGCD. Alternative RW2 scored poorly because of perceptions related to zero-

discharge and potential regulatory concerns over adequate treatment levels for the entire wastestream, which would be injected into the aquifer.

Alternative DR3 is potentially somewhat better in this regard as it does not involve operational changes to MRGCD deliveries, but is still considered problematic because of siting problems related to federal, tribal, and regional jurisdictions, and because of its proximity to Superfund sites. Alternative MC8, although absent the siting problems of DR3, involves the largest surface water diversion and would require complicated agreements with the MRGCD.

The most trouble-free was considered to be alternative DD1, a relatively simple and straight-forward, low-volume direct use alternative that does not require the participation of multiple agencies in implementation.

Alternatives DR4, DD2 through DD4, and MC2, MC7, and MC9 are, on balance, potentially subject to minor permitting concerns. Alternative DR4 suffers from the concern regarding a lack of regulations securing ownership of recharged water; DD2 and DD4 would require more extensive interface with the MRGCD; and DD3, MC2, MC7 and MC9 involve higher-volume diversion, although no recharge (or only a demonstration component in the case of MC9).

Alternative MC3 is somewhat more difficult because of the multiple jurisdictions involved. Moderate difficulty is anticipated for alternatives DR1 and DR2 owing to recharge and jurisdictional issues; for RW1 and RW3 because of technical and perception issues related to water quality; and for MC1, MC5, MC6, and MC10 due to recharge and jurisdictional issues.

Slightly greater difficulty would be expected for Alternatives DD5, which involves nearly the largest diversion and MC4 because it adds another level of jurisdictional issues and would create "mini" water supply districts.

Score	Severity of Impact the Problems Have on Implementation—Technical and Permitting Issues	Alternatives
1.	No noticeable impact; the problems do not impact the project schedule or budget or overall technical plan; positive public support is generated among some constituencies.	DD1
2.	Low severity; the problem results in delays of the project adding about 1 to possibly 2 years to the schedule. Permit delays may occur but are not significantly disruptive to project progress.	DR4 DD2, DD3, DD4 MC2, MC7, MC9
2.5	Intermediate between Levels 2 and 3.	MC3
3.	Moderate severity; the problem results in delays adding more than 2 years to possibly 4 years to the estimated time. Permit delays may cause some delay in project progress but do not threaten ultimate implementation.	DR1, DR2 RW1, RW3 MC1, MC5, MC6, MC10
3.5	Intermediate between Levels 3 and 4.	DD5, MC4
4.	High severity; the problem could result in an addition of more than 4 years up to about 6 years to the project. Some significant alterations in the basic design may be necessary and there may be some alterations in projected longer-term performance. Permit delays may be disruptive to project planning. The project's ultimate implementation is not threatened, but there may be some significant changes in the design.	DR3 MC8
4.5	Intermediate between Levels 4 and 5.	DR5, DR6 RW2
5.	Very high severity; the problem results in delays of over 6 to 10 years; the potential to bring the project to a stop before completion is significant; the delays are significant enough to threaten the ultimate implementation of the project; or permit delays have the potential of stopping the project.	GW0, GW1, GW2 RW4, RW5, RW6, RW7, RW8

### Public Support

The project team had extensive contact with the public throughout Phase 2 that provided some insight into public opinion. Surveys conducted for other purposes, such as conservation and overall City planning, were reviewed for indications of public sensitivities. A third source of reference was the team's knowledge of the water resources development experience of other cities across the country.

The project team believes that serious public opposition to reclamation/recharge alternatives RW1 through RW3 is likely, because of their high cost and concern over the location and safety of the injected reclaimed wastewater. This is especially true of RW2, the largest of these alternatives. GW2 calls for establishing new wellfields in areas outside the City's service area, which is likely to arouse opposition, at least from the public residing near a relocated wellfield.

Multicomponent alternatives potentially affecting lifestyles (MC3 and MC4), involving use of treated contaminated ground water (MC6), involving the largest diversions (MC8), or involving recharge near existing contamination (MC10) are likely to face a moderate to high degree of opposition.

Moderate problems related to public support—which might add 2 to 4 years to the 7-year implementation schedule—are likely for the large-volume diversion and direct use alternatives (DD3 and DD5), as well as some of the multicomponent alternatives that include attractive reuse projects (MC1, MC2, and MC5). The mid-level reclaimed water alternatives (RW4 and RW8), alternatives MC9 (which adds a popular constructed wetlands and project to MC2) is likely to be viewed somewhat more favorable, as would diversion and recharge alternatives DR1, DR5, and DR6 because of lower costs and popular features such as recycling, recharge ponds, and a riverwalk.

Alternatives DR2, DR3, DR4, DD1, DD2, and DD4 were judged to have low-severity impacts, again primarily because of relative cost considerations. No noticeable impact from the public would be anticipated for the lower impact (from the standpoint of visibility to the public) alternatives GW0, GW1, and RW5, RW6, and RW7.

Score	Severity of Impact the Problems Have on Implementation—Public Support Issues	Alternatives
1.	No noticeable impact; the problems do not impact the project schedule or budget or overall technical plan; positive public support is generated among some constituencies.	GW0, GW1 RW5, RW6, RW7
2.	Low severity; the problem results in delays of the project adding about 1 to possibly 2 years to the schedule. Permit delays may occur but are not significantly disruptive to project progress.	DR2, DR3, DR4 DD1, DD2, DD4
2.5	Intermediate between Levels 2 and 3.	DR1, DR5, DR6 RW4, RW8 MC9
3.	Moderate severity; the problem results in delays adding more than 2 years to possibly 4 years to the estimated time. Permit delays may cause some delay in project progress but do not threaten ultimate implementation.	DD3, DD5 MC1, MC2, MC5, MC7
3.5	Intermediate between Levels 3 and 4.	MC3, MC4, MC6, MC8, MC10
4.	High severity; the problem could result in an addition of more than 4 years up to about 6 years to the project. Some significant alterations in the basic design may be necessary and there may be some alterations in projected longer-term performance. Permit delays may be disruptive to project planning. The project's ultimate implementation is not threatened, but there may be some significant changes in the design.	GW2, RW1, RW3
4.5	Intermediate between Levels 4 and 5.	RW2

## Sustainability and Reliability Evaluation

Sustainability and long-term reliability are highly correlated and are therefore discussed jointly. The correlation is due to the fact that relying more heavily on sustainable

(renewable) resources preserves more water in the aquifer, thereby assuring maintenance of a ground-water drought reserve adequate to assure reliability, even in times of drought.

Sustainability (availability in perpetuity) and reliability (availability under adverse conditions) were considered equal in importance. An alternative's overall rating on this criteria was calculated by taking the average of the scores for these two elements.

Based on detailed ground-water modeling results (CH2M HILL, 1997d), the best performers under this criterion are the larger-volume diversion and direct use (DD3 and DD5) and multicomponent (MC1 through MC10) alternatives, which provide a fully sustainable supply through about 2020.

The diversion and recharge alternatives (DR1 through DR6) provide a slightly less sustainable and reliable supply, as do smaller-volume diversion and direct use alternatives (DD1, DD2, and DD4) and reclaimed water alternatives RW1 through RW3. These alternatives provide between 75 and 95 percent of the supply through 2020 from renewable (sustainable) surface water sources.

No-action alternative GW0 performs the worst in this regard, as the drought reserve would be more than completely exhausted during the planning period, and less than half the supply would be sustainable. The remaining alternatives are mid-level performers, providing 50 to 75 percent of the supply from renewable sources.

Score	Long-Term Sustainability of Supply	Alternatives
1.	The supply of water is sustainable at project design levels through the year 2020—100 percent of the supply comes from renewable sources.	DD3, DD5 MC1, MC2, MC3, MC4, MC5, MC6, MC7, MC8, MC9, MC10
2.	Between 75 and 95 percent of the supply through the year 2020 comes from renewable surface-water sources.	DR1, DR2, DR3, DR4, DR5, DR6 DD1, DD2, DD4 RW1, RW2, RW3
3.	Between 50 and 75 percent of the supply through the year 2020 comes from renewable surface-water sources.	GW1, GW2 RW4, RW5, RW6, RW7, RW8
4.	Between 25 and 50 percent of the supply through the year 2020 comes from renewable surface-water sources.	GW0

Score	Severity of Interruptions to Long-Term Reliability of the Supply of Water	Alternatives
1.	The drought reserve remains intact with an adequate margin of safety through the year 2060. There is limited potential for interruption of the water supply in both the short and long term.	DD3, DD5 RW2 MC1, MC2, MC3, MC4, MC5, MC6, MC7, MC8, MC9, MC10
2.	The drought reserve remains intact, but the margin of safety (<100%) is diminished. There are potentially small interruptions in the supply of water due to inadequate drought reserves or short-term problems. These interruptions are of short duration and do not require finding additional resources or impact provision of basic services to any customers.	DR1, DR2, DR3, DR4, DR5, DR6 DD1, DD2, DD4 RW1, RW3
3.	Between 50 and 100 percent of the drought reserve remains in the year 2060. There are potentially moderate interruptions in the supply of water. These interruptions either require use of other water supply resources or lead to stringent rationing of existing supplies.	GW2 RW4
4.	Between 0 and 50 percent of the drought reserve remains in the year 2060. There are potentially major interruptions in the supply of water, occurring during the planning horizon and potentially threatening the provision of water for customers and basic services to the City.	GW1 RW5, RW6, RW7, RW8
5.	By the year 2060 more than the entire drought reserve has been mined. In addition to major interruptions in the supply of water, which curtail basic services, widespread subsidence has the potential to further exacerbate delivery problems.	GW0

## Quality of Life Evaluation

As discussed in the previous chapter, this rather nebulous-sounding criterion refers to the degree to which the water supply alternative contributes to maintaining a healthy economy and public amenities (providing socioeconomic benefits) in a way that is viewed as fairly distributing the costs and benefits of providing water supplies (perceived equity).

The socioeconomic benefits derive not only from the absence of water shortages, but also from the perception that a credible plan exists for Albuquerque's water future and that an assured water supply is available. Equity considerations cover many issues, from the generational inequities that can result from today's citizens mining the aquifer at the expense of future generations, to the real and/or perceived disadvantages of being located near large water supply facilities without receiving more benefit from these facilities than other citizens.

For each of the alternatives, the scores for these two measures were averaged to arrive at an overall quality-of-life score.

## Socioeconomic Benefits

The strongest performance on measures of socioeconomic benefit are produced by the alternatives that create the most secure water future: the larger-volume diversion and direct use and multicomponent alternatives. Among these alternatives, those that include the use of low-cost recycled water in localized areas score slightly higher. (In general, alternatives incorporating recycling or reuse received slightly higher scores.)

Alternative RW2 also performs fairly well in this category, slightly better than the smaller-volume recharge and direct use alternatives.

Ground-water-only alternatives GW1 and GW2, and the remaining reclaimed water alternatives, present serious supply concerns. As a result, they adversely impact both the perception and the reality of Albuquerque's economic viability.

Score	Level of Support for Socioeconomic Benefits and Public Amenities	Alternatives
1.	Socioeconomic benefits including industrial and residential growth, provision of infrastructure benefits, and support for amenities such as parks, golf courses, greenbelts, and landscaping are fully supported in all areas of the City.	DD5 MC1, MC2, MC5, MC7, MC9
1.5	Intermediate between 1 and 2.	DD3 MC3, MC4, MC6, MC8, MC10
2.	Infrastructure needs are met and some growth is supported; perceived potential of shortages may curtail growth, but appropriate levels of public amenities are still supported.	RW2
2.5	Intermediate between 2 and 3.	DR1, DR2, DR3, DR4, DR5, DR6 DD1, DD2, DD4
3.	There is adequate supply for maintaining existing levels of amenities and industrial development, but inadequate to support growth and development.	GW2 RW1, RW3
3.5	Intermediate between 3 and 4.	GW1 RW4, RW5, RW6, RW7, RW8
4.	There is inadequate supply for most public amenities in the City such as public park growth, new greenbelts, or public golf courses; some infrastructure curtailment is required.	
5.	There is inadequate supply for public amenities, infrastructure curtailment is required.	GW0

## Perceived Equity of Costs and Benefits

The project team was generally pessimistic about the degree to which any of the alternatives would generate perceptions of equity, in part because even the best strategies face many challenges in the public arena. The best performers in this category were the simplest and smallest alternatives that affected the fewest constituencies: DR3, DR4, DD1, and RW4 through RW8. Alternative MC9 was judged to be only slightly less favorable because it uses smaller project components to spread benefits within the City.

Local ground-water-only alternatives GW0 and GW1 are inequitable not only because they exhaust the high quality ground water to the detriment of future generations, but also because they draw down the aquifer so severely that neighboring users of the aquifer would be affected. GW2, which locates new wells outside the City, causes aquifer drawdown in areas not receiving the benefit of City services.

Zero-discharge alternative RW2 is likely to raise concerns regarding who gets the “benefit” of having treated effluent recharging their part of the aquifer.

Many alternatives scored in the middle of the lower ratings because they involve changes in methods of delivery or use that some groups are likely to view as unfair.

Score	Degree to Which Benefits and Costs are Perceived to be Equitably Distributed	Alternatives
3.	The City receives calls, letters, visits, or hears statements in public meetings identifying alleged inequities in either cost bearing or in the distribution of benefits from the water supply plan.	DR3, DR4 DD1 RW4, RW5, RW6, RW7, RW8
3.5	Intermediate between levels 3 and 4.	MC9
4.	Some recognized groups may hold public meetings, start petitions, or make requests of elected officials regarding changes that they allege need to be made in the structure of funding or implementing the water supply plan.	DR1, DR2, DR5, DR6, DD2, DD3, DD4, DD5 RW1, RW3 MC2, MC5, MC6, MC7, MC8, MC10
4.5	Intermediate between Levels 4 and 5.	MC1, MC3, MC4
5.	There are publicly organized meetings focused on water supply difficulties or inequities; there is negative coverage in the local news and permits or other important aspects of the plan are reviewed.	GW1
6.	Analyses show that inequities may be so serious as make implementation unlikely. (For example, alternatives that would allow resources to be depleted below levels adequate to supply future generations within the planning period would be highly unfair to those future generations.)	GW0, GW2 RW2

## Financial Evaluation

Table 4-1 summarizes anticipated project costs for 2000 to 2020, expressed in net present value terms. Costs related to facilities design and construction, operations and maintenance, and environmental mitigation are all included, as are credits/costs (depending on the alternative) related to the need for arsenic treatment facilities.

The initial evaluation process simply assigned scores based on the total dollar costs. Because the total range was so large, however, during the final evaluation process the

categories covered only the costs of the 14 most promising alternatives retained for further evaluation. This narrowed the range considerably.

TABLE 4-1

## Summary of Financial Impacts

All values represent opinions of costs (2000-2020) shown as net present value in \$million.

Alt.	New Water Supply Facility				Ground-Water Costs	Potential Savings (Relative to GW1)			Net Financial Impact
	Capital Costs	Average Annual O&M Costs	New Water Supply Facility Costs	Potential Additional Costs		Reduced Ground-Water Development Cost	Expected Arsenic Treatment Savings	Expected Drought, Subsidence Savings	
GW0	-	-	-	3	136	(1)	(34)	(669)	888
GW1	-	-	-	2	90	-	-	-	92
GW2	115	3.0	146	2	74	1	(4)	59	151
DR1	94	6.0	166	3	88	0	10	59	186
DR2	65	7.0	142	3	66	1	31	70	86
DR3	47	1.0	62	5	90	0	0	45	112
DR4	70	7.0	147	3	66	1	31	70	91
DR5	77	6.0	151	7	89	0	0	59	187
DR6	83	6.0	157	7	89	0	-	59	193
DD1	76	6.0	152	3	47	2	24	72	63
DD2	73	7.0	150	3	47	2	24	72	61
DD3	128	14.0	288	7	17	4	30	83	127
DD4	86	7.0	170	2	47	2	24	72	80
DD5	152	16.0	343	8	9	4	31	85	162
RW1	254	18.0	463	3	88	0	-	59	494
RW2	540	41.0	1,022	4	84	0	-	74	1,030
RW3	217	16.0	405	3	89	0	0	51	445
RW4	96	0.5	101	0	74	0	5	27	127
RW5	25	1.0	34	0	81	0	3	19	85
RW6	34	1.0	43	0	78	0	4	20	85
RW7	11	0.5	16	0	90	-	0	-	106
RW8	56	3.0	93	0	77	0	4	17	136
MC1	152	14.0	317	7	16	4	30	86	150
MC2	153	14.0	317	7	13	4	30	83	147
MC3	131	14.0	292	7	15	4	30	83	126
MC4	176	14.0	337	7	14	4	30	84	168
MC5	151	14.0	310	7	15	4	30	86	141
MC6	136	14.0	296	7	20	3	29	88	136
MC7	150	14.0	312	7	13	4	30	83	142
MC8	148	17.0	342	7	11	4	31	87	164
MC9	152	14.0	315	7	10	4	31	83	139
MC10	139	13.0	294	8	13	4	29	83	126

Notes: All values unless otherwise noted represent net present worth (NPW) (during the period 2000 through 2020, except for the drought and subsidence estimate, which includes the planning period through 2060) assuming a 6 percent discount factor. Potential additional costs include site-specific project uncertainties, such as size of surface recharge facilities, environmental mitigation needs, well redevelopment and treatment adjustments for recharge alternatives, etc. Ground-water costs include new wells, well replacements, and pumping costs. Expected arsenic treatment costs reflect a 50 percent probability of a 5-ppb standard and a 40 percent chance of a 20-ppb standard, and a 10 percent chance that the standard stays at 50 ppb. Potential drought and subsidence costs include costs of landscape replacement should a drought reserve not be available and damage to infrastructure and buildings that might result from land surface subsidence. The net financial impact represents the NPW of new surface- and ground-water facilities, less potential savings, relative to alternative GW1, ground-water pumping with conservation.

## Preliminary Rankings

The project team relied on decision analysis techniques in establishing the framework and computing the overall scores and rankings for evaluation (CH2M HILL, 1997a). Creating a common scale of 0 to 1 allows comparison of scores for the various criteria. Table 4-2 shows the first cut at a preliminary ranking that points up the strengths and weaknesses of each alternative. Note that in this table, the *higher* score (closer to 1) is better, not the *lower* score (closer to 0) as in the previous tables.

TABLE 4-2

Performance of Alternatives for the Fundamental Objectives  
(Unweighted Utility, 0 = worst, 1 = best)

	Alternative	Environmental Protection	Implementability	Sustainability and Reliability	Financial Support	Quality of Life
GW0	Continued Current Trends	0.63	0.00	0.15	0.11	0.00
GW1	Local Ground Water with Conservation	0.65	0.00	0.45	1.00	0.25
GW2	Relocated Ground Water Pumping	0.91	0.00	0.51	0.85	0.15
DR1	Injection of San Juan-Chama Water	0.79	0.85	0.70	0.83	0.53
DR2	Aquifer Storage and Recovery of SJC Water	0.86	0.85	0.70	0.99	0.53
DR3	Spreading Basin Recharge	0.77	0.60	0.70	0.97	0.63
DR4	ASR with Infiltration Galleries	0.84	0.95	0.70	0.98	0.63
DR5	Enhanced Surface Recharge	0.80	0.30	0.70	0.82	0.53
DR6	Enhanced Surface Recharge/Recreation	0.80	0.30	0.70	0.81	0.53
DD1	Direct Use of SJC (Infiltration)	0.82	0.95	0.70	0.99	0.63
DD2	Direct Use of SJC (MRGCD)	0.82	0.95	0.70	1.00	0.53
DD3	Enhanced Direct Use of SJC	0.79	0.85	1.00	0.82	0.70
DD4	Direct Use of SJC (Modular)	0.86	0.95	0.70	0.96	0.53
DD5	Maximized Surface Water	0.79	0.73	1.00	0.76	0.80
RW1	Reclamation and Recharge—SWRP and West Side	0.83	0.60	0.70	0.41	0.45
RW2	Reclamation and Recharge—Zero Discharge	0.90	0.30	0.93	0.00	0.30
RW3	Reclamation and Recharge	0.83	0.60	0.70	0.46	0.45
RW4	Nonpotable Reuse—Citywide	0.73	0.00	0.51	0.89	0.50
RW5	Focused Nonpotable Reuse	0.73	0.00	0.45	1.00	0.50
RW6	Nonpotable Reuse—Constructed Wetlands	0.71	0.00	0.45	0.99	0.50
RW7	Constructed Wetlands	0.75	0.00	0.45	0.97	0.50
RW8	Satellite Nonpotable Reuse	0.71	0.00	0.45	0.88	0.50
MC1	Direct Use, ASR, Recharge Enhancements, Reuse	0.79	0.85	1.00	0.78	0.73
MC2	Direct Use and Focused Nonpotable Reuse	0.79	0.85	1.00	0.78	0.80
MC3	Direct Use, Nonpotable Surface Water	0.79	0.73	1.00	0.82	0.63
MC4	Direct Use, Nonpotable Ground Water	0.79	0.73	1.00	0.75	0.63
MC5	Direct Use, ASR, Focused Reuse	0.79	0.85	1.00	0.80	0.80
MC6	Direct Use of SJC, West-Side Recharge and Remediation	0.79	0.73	1.00	0.81	0.70
MC7	Direct Use, Focused Reuse with Constructed Wetlands	0.79	0.85	1.00	0.79	0.80
MC8	Direct Use of SJC with Recharge	0.79	0.73	1.00	0.76	0.70
MC9	Direct Use, Focused Reuse with Constructed Wetlands, ASR, and Shallow Ground Water	0.79	0.90	1.00	0.79	0.85
MC10	Direct Use with Calabacillas Arroyo Recharge	0.79	0.73	1.00	0.82	0.70

## Scores on Individual Criteria

All alternatives scored well on the environmental protection criterion, in part because the project team worked from the beginning to shape approaches that are environmentally sound. The environmental protection criterion thus fails to provide strong distinctions that might lead to one or more strategies emerging as the “environmental” alternative. None are perfect; all score well.

The lower-volume diversion alternatives using infiltration galleries (DR2, DR4, DD1, DD2, and DD4) do best with regard to implementability. Infiltration galleries are underground perforated pipes that operate similar to a French drain. They would be located near the Rio Grande and would collect shallow ground water seeping away from the river. Because they can be located under existing service roads and are not visible once they are built, infiltration galleries represent a low-impact means of diverting water. The lower-volume diversion alternatives are also easier to implement simply because they are smaller in scale and use only a portion of the City’s San Juan-Chama water.

The larger-volume diversion and direct use and multicomponent alternatives (DD3, DD5, and MC1 through MC10) perform best in the sustainability category. Using large volumes of surface water emphasizes the use of renewable resources and preserves aquifer supplies, allowing the maintenance of ground-water reserves that could be critical to supply reliability in times of prolonged drought.

Multicomponent alternatives MC2, MC5, MC7, MC9 and DD5 (maximized surface water use) produce the best quality-of-life performance, because they provide more socioeconomic benefits and amenities. The multicomponent alternatives take advantage of small-scale recycling and shallow ground-water projects that provide irrigation for public landscaping and lower cost, lower quality industrial water supplies that support local businesses. They also represent a very secure future supply, allaying fears about how Albuquerque would cope with future droughts or other natural adversities affecting the water supply.

Financial support performance is generally highest for those alternatives that involve the lowest facility construction costs (GW1, DR2 through DR4, DD1 and DD2, DD4, and RW5 through RW7), and worst for GW0 and large-scale recycling alternatives RW1 through RW3. These alternatives tend not to score well in other categories. Thus, no alternative emerged as both very low cost and able to deliver benefits consistently in other categories of interest. This implies a trade-off between the amount of money invested and the benefits to be received. No low-cost solution provides sustainability in the coming decades, for example.

## Insights from Preliminary Evaluation

This preliminary look at how the alternatives fare under the various criteria provides insight into the factors that contribute to sound strategy decisions.

Some alternatives score well on most or all of the criteria. The multicomponent alternatives that divert large volumes of surface water using infiltration galleries and orient the water for direct use as a part of the City’s water supply (MC9, MC5 and MC7) score well consistently. Why is this?

By using surface water as a direct part of the municipal supply, they avoid potential problems with maintaining the legal right to water stored underground, do not have the limitations of some of the recharge alternatives with regard to storing water where it is needed, and avoid the potential perceptions of health or environmental risks that accompany recycling projects.

The multicomponent (MC) alternatives also score well overall because in addition to being sustainable, they take advantage of both large and small project opportunities to enhance the quality of life and provide lower quality-lower cost supplies for uses that do not require high quality treated surface water or ground water from the deep aquifer.

The larger size and complexity of the multicomponent (MC) alternatives are both their strength and their weakness. They cost more than small-scale alternatives, and—by including different types of projects—entail a wider variety of potential permitting and acceptability issues.

Many of the diversion and recharge (DR) alternatives occupy the middle ranks. These alternatives are technically and environmentally attractive, but would have to break new regulatory ground in gaining assurance that water City ratepayers pay to divert, treat, and recharge remains theirs to use in the future.

Study of locations that showed good potential for natural recharge found that they tended to also be the location of contamination that could be carried into the deep aquifer. Recent studies have shown that the locations where relatively rapid natural recharge to the deep aquifer occurs are much more rare than previously believed.

In addition, the diversion and recharge (DR) alternatives do not eliminate the need for water treatment to assure that water reaching the deep aquifer is clean. Once the costs of treatment must be incurred, then direct use in the municipal supply provides a better “return” on the investment made than does recharging the aquifer, because all of the direct supply is available for immediate use.

Reclaimed (recycled) water (RW) alternatives sank to the bottom of the ranking consistently. The large-scale alternatives (RW1 through RW3) cost about twice as much as other alternatives because they require extensive treatment to assure that supplies are safe and due to distribution or satellite facility costs.

Although they use proven treatment technologies, public perceptions of the reliability, value and safety of widespread recycled water use remain mixed. The discussion of these alternatives with community leaders and members of the general public invariably led to questions regarding safety, not only to people and animals, but also the potential for contamination or damage of the aquifer. Regulatory officials share some of this skepticism, making permitting more difficult.

The smaller-scale recycling (RW) alternatives offer attractive features, but are not large enough in themselves to address core problems of sustainability and reliability.

The ground-water-only (GW) alternatives were consistently at the bottom of the rankings. Because these alternatives all rely on ground-water mining—either in or beyond the metropolitan area—they score low on sustainability, deplete potential ground-water drought reserves, jeopardize the security of the City’s ownership of San Juan-Chama water by failing to put it to beneficial use, raise doubts about the ability to sustain a healthy economy, and present serious issues of generational and regional inequity. Note that the “no-action” alternative of continuing past practices and failing to achieve conservation goals is the most expensive of the 32 alternatives.

The following chapter shows how these rankings are affected by being combined into a single score for each alternative, with various weighting schemes applied to reflect different priorities.

# Chapter 5

## Final Evaluation

This chapter covers further steps in the evaluation process, which focused on prioritizing the criteria, confirming that the performance measures were as accurate as possible at this stage of the process, and considering how various outcomes of uncertain future events would affect the attractiveness of promising alternatives. The steps were:

- To test the effects of assigning priorities (weights) to the criteria that reflect their relative importance and to apply an appropriate weighting scheme.
- To narrow the field of alternatives to those showing the most promise, and to seek more precise measures of performance for criteria to better distinguish among promising alternatives with similar ratings.
- To take into account uncertainties related to future wastewater stream standards, arsenic treatment costs, and State Engineer Office administrative rules affected by the new USGS model of the aquifer.
- To review the resulting final evaluation to prepare for developing the policies and implementation plans that the highest ranking alternative would entail.

As mentioned earlier, these activities involved the application of logical and mathematical concepts that would take some time to describe in this *Summary Report*. Refer to CH2M HILL (1997a) for a detailed explanation and the calculations performed. The project team chose to apply these methods because they represent the best available technology for establishing a realistic and defensible basis for strategy selection. They also provide documentation of the thought processes and values that went into the evaluation.

### Assigning Weights and Priorities to the Criteria

The project team discussed the relative importance of the criteria in several internal meetings, with stakeholders such as the regulatory officials, and at presentations before community groups and the general public.

Two public forums focused primarily on the criteria and their relative importance. Forum participants were asked to suggest their own weighting scheme on a written feedback form completed at the forums. Their responses reflected varying degrees of concern about the environment, sustainability, cost, and other issues. Despite their diversity, the weighting schemes they suggested had one common feature: virtually all felt that *all* the criteria merited serious consideration in making a final decision. Very few respondents gave weights of more than 30 (out of a total of 100 points to allocate among five criteria) to any one criterion.

The Customers Advisory Committee and City Staff Steering Committee members also actively participated in considering appropriate weighting. In both these groups, individual differences in viewpoint led to differing weight assignments. Again, however, consensus that all criteria merited serious consideration was apparent.

The unifying issues that emerged from public involvement activities overall were aquifer protection and sustainability. With rare exception, people mentioned these as critical to their concerns, regardless of whether those concerns focused on environmental protection, economic growth, or other areas.

As a starting point, the project team members set a weighting scheme based on project objectives and professional judgment. They assigned a 40 percent weight to the sustainability and reliability criterion, because the project goal is to provide a “safe and sustainable” supply. They assigned the remaining four criteria 15 percent each, considering them all quite important. The team also considered a weighting scheme that placed heavy emphasis (40 percent) on implementability, believing that the worst alternative would be one that remained on the shelf rather than being put into service.

Because no consistent or heavily skewed weighting schemes emerged from public involvement activities, the team devised sets of weights, each of which reflected placing high priority on one criteria and much lower, but fairly evenly spread priority on the remaining criteria. One weighting scheme simply assigned 20 percent weights to each of the five criteria. These weighting schemes define the columns in Table 5-1 below.

TABLE 5-1

Sensitivity of Performance to Relative Weights

*The columns show the effects of different weighting schemes on alternative scores***EMPHASIS PLACED ON . . .**

<b>Environmental</b>		<b>Implementability</b>	<b>Equal Weights</b>	<b>Sustainable</b>	<b>Primarily Cost</b>	<b>Quality of Life</b>
<b>OBJECTIVE</b>						
<b>Environmental Protection</b>	<b>40%</b>	<b>15%</b>	<b>20%</b>	<b>15%</b>	<b>15%</b>	<b>15%</b>
<b>Implementability</b>	<b>15%</b>	<b>40%</b>	<b>20%</b>	<b>15%</b>	<b>15%</b>	<b>15%</b>
<b>Sustainability and Reliability</b>	<b>15%</b>	<b>15%</b>	<b>20%</b>	<b>40%</b>	<b>15%</b>	<b>15%</b>
<b>Project Cost</b>	<b>15%</b>	<b>15%</b>	<b>20%</b>	<b>15%</b>	<b>40%</b>	<b>15%</b>
<b>Support of Quality of Life</b>	<b>15%</b>	<b>15%</b>	<b>20%</b>	<b>15%</b>	<b>15%</b>	<b>40%</b>
<b>Rank</b>		<b>Ratings</b>				
		<i>(0 = worst; 1.0 = best)</i>				
1	MC9 0.85	MC9 0.87	MC9 0.87	MC9 0.90	DD1 0.86	MC9 0.86
2	MC5 0.83	DR4 0.85	MC5 0.85	MC5 0.89	DR4 0.86	MC5 0.84
3	MC7 0.83	DD1 0.85	MC7 0.85	MC7 0.88	DD2 0.85	MC7 0.83
4	MC2 0.83	MC5 0.85	MC2 0.84	MC2 0.88	MC9 0.85	MC2 0.83
5	DR4 0.82	MC7 0.85	DD3 0.83	DD3 0.87	DD4 0.84	DD5 0.81
6	DD3 0.82	MC2 0.85	MC1 0.83	MC1 0.87	DR2 0.84	MC1 0.80
7	DD1 0.82	DD2 0.84	DR4 0.82	DD5 0.86	MC5 0.83	DD3 0.80
8	MC1 0.82	DD4 0.84	DD1 0.82	MC10 0.85	MC7 0.83	MC10 0.78
9	DD4 0.81	DD3 0.84	DD5 0.81	MC6 0.85	DD3 0.83	MC6 0.78
10	DD5 0.81	MC1 0.83	MC10 0.81	MC8 0.85	MC2 0.83	DR4 0.77
11	DD2 0.80	DR2 0.80	MC6 0.80	MC3 0.84	MC1 0.82	MC8 0.77
12	DR2 0.80	DD5 0.79	DD2 0.80	MC4 0.83	MC10 0.81	DD1 0.77
13	MC10 0.80	MC10 0.79	DD4 0.80	DR4 0.79	MC6 0.81	MC3 0.75
14	MC6 0.80	MC6 0.78	MC8 0.79	DD1 0.79	DD5 0.80	MC4 0.74
15	MC8 0.79	MC8 0.78	MC3 0.79	DD2 0.77	MC3 0.80	DD2 0.73
16	MC3 0.79	MC3 0.77	DR2 0.79	DD4 0.77	DR3 0.79	DD4 0.73
17	MC4 0.78	DR1 0.77	MC4 0.78	DR2 0.76	MC8 0.79	DR2 0.72
18	DR1 0.75	MC4 0.76	DR1 0.74	DR1 0.73	MC4 0.77	DR3 0.71
19	DR3 0.74	DR3 0.70	DR3 0.73	DR3 0.73	DR1 0.76	DR1 0.69
20	DR5 0.67	RW3 0.61	DR5 0.63	DR5 0.65	DR5 0.68	DR5 0.60
21	DR6 0.67	RW1 0.60	DR6 0.63	DR6 0.65	DR6 0.67	DR6 0.60
22	RW3 0.66	DR5 0.55	RW3 0.61	RW3 0.63	RW5 0.65	RW3 0.57
23	RW1 0.65	DR6 0.55	RW1 0.60	RW1 0.62	RW6 0.64	RW1 0.56
24	GW2 0.59	RW2 0.44	RW5 0.54	RW2 0.59	RW7 0.64	RW5 0.53
25	RW2 0.59	RW5 0.40	RW7 0.53	RW4 0.52	RW4 0.62	RW7 0.52
26	RW7 0.59	RW7 0.40	RW6 0.53	RW5 0.51	GW1 0.60	RW6 0.52
27	RW5 0.58	RW6 0.40	RW4 0.53	RW7 0.51	RW8 0.60	RW4 0.52
28	RW4 0.58	RW4 0.40	RW8 0.51	RW6 0.51	GW2 0.57	RW8 0.51
29	RW6 0.57	RW8 0.38	RW2 0.48	RW8 0.49	RW3 0.57	RW2 0.44
30	RW8 0.56	GW2 0.36	GW2 0.48	GW2 0.49	RW1 0.55	GW1 0.42
31	GW1 0.52	GW1 0.35	GW1 0.47	GW1 0.47	RW2 0.36	GW2 0.40
32	GWO 0.29	GWO 0.13	GWO 0.18	GWO 0.17	GWO 0.16	GWO 0.13

Table 5-1 shows that some alternatives ranked high, regardless of the weights applied. Others consistently occupy the middle rankings, while still others sink repeatedly to the bottom.

Table 5-1 shows that the choice of a “best” alternative does not depend as much on the priorities placed on the criteria as it does on the basic features of the alternatives. This is because features tend to be attractive or unattractive across several criteria categories. This is encouraging, because it implies that people with diverse opinions should be able to agree on the preferred alternative—or at least on a small group of preferred strategies—providing many kinds of benefits.

Table 5-1 shows that alternative MC9 (diversion of 97,000 ac-ft/yr of San Juan-Chama and Rio Grande water through infiltration galleries, plus small-scale recycling, shallow ground-water, and ASR projects) has the best overall performance, followed closely by MC7, MC5, MC2, and DD3 (large-volume direct use of surface water use). The reclaimed water alternatives and the ground-water-only alternatives perform poorly.

The major tradeoff implied by the evaluation is one between cost and benefits. For example, the lowest cost alternatives do not provide the benefits of sustainability through 2020; some of the alternatives in the mid-range of costs do. Ideally, at least one low-cost alternative would provide virtually all of the benefits of more costly options. This is not evident in this case; benefits are only gained by paying more to add size and/or facilities.

## Narrowing the Field of Alternatives

In order to focus efforts on the most promising alternatives, the project team narrowed the field of alternatives under consideration to the 14 that scored best under the weighting scheme that emphasized sustainability and reliability, the primary project mission. Each of these 14 alternatives—listed in Table 5-2 below—was considered to have the potential to rise to the top of the ranking. The list includes a low-volume diversion and recharge alternative (DR4), a low-volume diversion and direct use alternative (DD1), and the multicomponent alternatives.

**TABLE 5-2**  
Alternatives Retained for Final Prioritization

DR4	ASR with Infiltration Galleries
DD1	Direct Use of SJC (Infiltration)
DD3	Enhanced Direct Use of SJC
DD5	Maximized Surface Water
MC1	Direct Use, ASR, Recharge Enhancements, Reuse
MC2	Direct Use and Focused Nonpotable Reuse
MC3	Direct Use, Nonpotable Surface Water
MC4	Direct Use, Nonpotable Ground Water
MC5	Direct Use, ASR, Focused Reuse
MC6	Direct Use of SJC, West-Side Recharge and Remediation
MC7	Direct Use, Focused Reuse with Constructed Wetlands
MC8	Direct Use of SJC with Recharge
MC9	Direct Use, Focused Reuse with Constructed Wetlands, ASR, and Shallow Ground Water
MC10	Direct Use with Calabacillas Arroyo Recharge

## Improving Performance Measures

To fine tune the evaluation, the project team re-examined the performance measures with a view to finding better means of distinguishing among promising alternatives that had similar ratings. They determined that more precise performance levels could be developed for the reliability and sustainability measure. For the other objectives (environmental protection, implementability, quality of life, and financial impact) the current definition of project detail does not allow more precise measures, although adjustments in the scales of measurement sharpened the distinctions among high-scoring alternatives.

### Sustainability and Reliability Measurement

In the preliminary evaluation, the amount of the drought reserve remaining at the end of the planning period was used as the measure for reliability. Based on a review of the ground-water modeling results, the project team determined that the amount of additional aquifer mining better served to indicate reliability. Using total additional aquifer mining as the performance measure made it possible to differentiate among the multicomponent and large-volume diversion and direct use alternatives, all of which scored at the highest level in the preliminary evaluation.

The amount of additional mining for the 14 most promising alternatives ranges from about 0.3 million to 2.7 million acre feet through the planning period. The project team assigned a utility of 1.0 (the highest possible rating) to the alternative with the least additional mining and a utility of 0 (the lowest possible rating) to the alternative with the most aquifer mining. This created a broader range of ratings for the finalist alternatives.

### Financial Support Measurement

In much the same way, the scale for rating financial support was modified to take into account the narrower range of potential costs represented by the 14 most promising alternatives. As with aquifer mining, the least expensive alternative received a score of 1.0 and the most expensive received a score of 0, with the remaining alternatives receiving intermediate ratings consistent with their total cost impacts.

## Final Evaluation Results

The following table illustrates the evaluation results once the fine-tuning of measures was completed.

Again, all of the alternatives score well in the environmental protection category. Alternative DR4, which avoids the temporary construction impacts of a river pipeline crossing scores slightly better than the others in this regard.

Implementability scores slightly favor the lower-volume diversion alternatives DD1 and DR4, but multicomponent alternatives MC7 and MC9 also do well.

**TABLE 5-3**  
Refined Evaluation of the Alternatives  
(Unweighted Utility, 0 = worst, 1 = best)

Alternative		Environmental Protection	Implementability	Sustainability and Reliability	Financial Support	Quality of Life
DR4	ASR with Infiltration Galleries	0.84	0.95	0.01	0.94	0.50
DD1	Direct Use of SJC (Infiltration)	0.83	0.95	0.06	1.00	0.50
DD3	Enhanced Direct Use of SJC	0.81	0.86	0.96	0.35	0.76
DD5	Maximized Surface Water	0.81	0.65	1.00	0.05	0.93
MC1	Direct Use, ASR, Recharge Enhancements, Reuse	0.81	0.86	0.98	0.17	0.50
MC2	Direct Use and Focused Nonpotable Reuse	0.81	0.86	0.98	0.17	0.93
MC3	Direct Use, Nonpotable Surface Water	0.81	0.65	0.98	0.34	0.33
MC4	Direct Use, Nonpotable Ground Water	0.81	0.65	0.98	0	0.33
MC5	Direct Use, ASR, Focused Reuse	0.81	0.86	0.98	0.24	0.84
MC6	Direct Use of SJC, West-Side Recharge and Remediation	0.81	0.65	0.98	0.30	0.76
MC7	Direct Use, Focused Reuse with Constructed Wetlands	0.81	0.86	0.98	0.21	0.93
MC8	Direct Use of SJC with Recharge	0.81	0.65	1.00	0.06	0.76
MC9	Direct Use, Focused Reuse with Constructed Wetlands, ASR, and Shallow Ground Water	0.82	0.92	0.98	0.21	0.99
MC10	Direct Use with Calabacillas Arroyo Recharge	0.81	0.65	0.98	0.33	0.76

The large-volume diversion alternatives score highest in the sustainability and reliability category. They also score better on the quality of life scale, especially with regard to socioeconomic benefits.

The smaller, low-volume diversion alternatives score higher than the larger projects with regard to project cost, although the cost range is not very great.

The following table shows the rankings of the finalist alternatives when different weighting schemes are applied. Alternatives MC9, MC5, and MC7 remain among the highest ranking alternatives for all weighting scenarios. MC7 and MC5 include the same large-volume, direct use of San Juan-Chama water diverted using infiltration galleries that MC9 includes, but have different combinations of smaller projects. Only if project cost is the overriding concern do the low volume-diversion alternatives (DD1 and DR4) rise to the top of the ranking.

Alternative MC9, on balance, best meets all of the objectives of the Water Resources Management Strategy. It is the preferred alternative under all criteria except cost, and even in this category does better than most of the other finalist alternatives.

Alternatives MC2, MC10, DD3, and DD5 are somewhat less favorable due to lower scores for implementability and/or somewhat higher costs. Overall, the low-volume diversion alternatives are less preferred than those that provide a sustainable supply.

TABLE 5-4  
Final Evaluation of Preferred Alternatives  
*Sensitivity of Performance to Relative Weights*

PLACING EMPHASIS ON . . . .					
Environment	Implementability	Equal Weights	Sustainable	Primarily Cost	Quality of Life
<b>OBJECTIVE</b>					
Environmental Protection	40%	15%	20%	15%	15%
Implementability	15%	40%	20%	15%	15%
Sustainability and Reliability	15%	15%	20%	40%	15%
Project Cost	15%	15%	20%	15%	40%
Support of Quality of Life	15%	15%	20%	15%	40%

Rank	Ratings (0 = worst; 1.0 = best)											
	MC9 0.79		MC9 0.82		MC9 0.78		MC9 0.83		DD1 0.75		MC9 0.84	
1	MC9	0.79	MC9	0.82	MC9	0.78	MC9	0.83	DD1	0.75	MC9	0.84
2	MC7	0.77	MC7	0.78	MC7	0.76	MC7	0.81	DR4	0.72	MC7	0.80
3	MC2	0.76	MC2	0.78	MC2	0.75	MC2	0.81	DD3	0.65	MC2	0.79
4	DD3	0.76	DD3	0.77	DD3	0.75	MC5	0.80	MC9	0.64	MC5	0.77
5	MC5	0.76	MC5	0.77	MC5	0.75	DD3	0.80	MC5	0.62	DD3	0.75
6	MC10	0.73	DD1	0.74	MC10	0.70	MC10	0.77	MC7	0.62	DD5	0.74
7	MC6	0.73	DR4	0.72	MC6	0.70	MC6	0.77	MC10	0.61	MC10	0.72
8	DD5	0.71	MC1	0.71	DD5	0.68	DD5	0.76	MC2	0.60	MC6	0.71
9	DD1	0.71	MC10	0.69	DD1	0.67	MC1	0.74	MC6	0.60	MC8	0.68
10	MC1	0.70	MC6	0.69	MC1	0.66	MC8	0.74	MC3	0.55	DD1	0.63
11	DR4	0.70	DD5	0.68	MC8	0.65	MC3	0.71	MC1	0.54	MC1	0.62
12	MC8	0.69	MC8	0.65	DR4	0.65	MC4	0.66	DD5	0.53	DR4	0.61
13	MC3	0.67	MC3	0.63	MC3	0.62	DD1	0.52	MC8	0.50	MC3	0.55
14	MC4	0.62	MC4	0.58	MC4	0.55	DR4	0.49	MC4	0.42	MC4	0.50

## A Double-Check on the Highest Ranking Alternative

The outcome of several future events will have a major impact on the City's water resources strategy. To assess how these uncertainties might affect the selection of a preferred alternative, the project team estimated and applied potential future costs related to:

- Future changes in the arsenic standards set under the Safe Drinking Water Act
- Future changes in Rio Grande water quality standards set under the Clean Water Act and New Mexico Water Quality Control Commission regulations
- Future changes in the methods that the State Engineer uses to administer water rights within the Middle Rio Grande Valley

Of course, many other uncertainties will also come into play. The project team considered these three, however, because they appeared to be the most likely to affect the selection of a preferred alternative.

In evaluating these three critical uncertainties, the one that predominated in distinguishing among alternatives was the level at which Rio Grande water quality standards will be set under the federal Clean Water Act and State Water Quality Control Commission standards. These standards govern the quality of the effluent discharged from the City's Southside Water Reclamation Plant into the Rio Grande. Arsenic standards for drinking water played a secondary role primarily in combination with the Rio Grande standards. Changes in the SEO rules governing water rights affected all high-ranking alternatives equally.

## **Rio Grande Water Quality Standards**

The Rio Grande water quality standards affect the amount of treatment that must be applied to the City's wastewater before it is discharged into the river. The strictest of the potential standards imply bringing wastewater effluent to drinking water standards or better.

The otherwise unattractive large-scale recycling alternatives (RW1 through RW 3) suggest effective means of addressing the circumstances posed by extremely stringent Rio Grande water quality standards. Although their costs are much greater than those of other solutions that meet current standards, they would look much more competitive if the additional wastewater treatment they entail is mandated. The project team kept the large-scale recycling alternative RW2 under consideration for this reason.

Based on discussions with the City Wastewater Utility, U.S. Environmental Protection Agency (EPA) and other agencies involved, the project team estimated a 25 percent probability that the standards would remain similar to those in the existing National Pollutant Discharge Elimination System (NPDES) permit. We estimated a 5 percent chance that the standard would be similar to the very stringent standard proposed by the Pueblo of Isleta (17.5 parts per trillion [ppt] of arsenic). Because recent work by EPA suggests that the arsenic standard for wastewater effluent is more likely to be about 20 parts per billion (ppb), the project team assigned a 70 percent probability to water quality standards being set at 20 ppb, which we consider an "intermediate" level. Allowable concentrations of silver in wastewater effluent, which could be reduced to about 1 ppb in the "intermediate" scenario, would trigger the need for some additional wastewater treatment, while the 20 ppb arsenic standard would not.

The project team estimated cost impacts based on the additional wastewater treatment that would be required. No additional costs would be needed to meet the existing NPDES permit requirements. Meeting the most stringent standard considered possible (17.5 ppt for arsenic ) would require an additional capital outlay of about \$300 million and about \$50 million per year in operations and maintenance (O&M) costs for Alternative MC9. (The zero-discharge Alternative RW2 would not need to meet this stringent standard and no additional treatment facilities would be needed.) Intermediate-level standards would require capital outlays on the order of \$130 million, plus about \$8 million in annual O&M costs for Alternative MC9. Again, Alternative RW2 would not require these additional costs.

## **Estimated Cost Impacts**

Because the extremely-stringent-standards scenario would take advantage of the benefits of zero-discharge alternative RW2, we estimated the total cost impacts on preferred alternative MC9 and RW2. Although otherwise a mediocre to poor performer, RW2 (large-scale recycling with no discharge to the river) would not require the additional capital and O&M investment to meet more stringent wastewater effluent standards.

Accounting for all costs and calculating the probabilities of various future outcomes, alternative MC9 has an expected cost of about \$597 million (net present value through 2020), while RW2 has a significantly higher expected cost of \$1,230 million.

RW2 would be less expensive than MC9 only if two unlikely events both occur. Wastewater discharge quality standards would have to be very stringent **and** drinking water standards would have to allow relatively higher arsenic levels of 20 ppb or 50 ppb. (Because RW2 requires the use of more ground water, its treatment costs to remove arsenic from drinking water would be much greater than MC9.)

Regardless of which regulatory standards are set, the cost for RW2 falls within the range of \$1,116 million to \$1,331 million. In contrast, MC9 costs change radically depending on which of the potential Rio Grande water quality standards must be met, rising from about \$350 million for the least stringent standards considered to about \$1,370 million for the most stringent. Note that at the level of precision in the cost estimates, the maximum amount for MC9 is not significantly different than the maximum cost estimated for RW2.

Given the low probability of the outcome that would drive costs for MC9 to the upper limit, however, MC9 continues to be the more attractive alternative. The project team estimates that there is less than a 10 percent chance that the total costs of MC9 will exceed \$680 million. In other words, there is about a 90 percent chance that the regulatory outcome will be one that will make a version of MC9 that costs less—and possibly much less—than \$680 million adequate to meet standards. Even if MC9 costs are driven to their highest level, they are still comparable to the approximately \$1.3 billion costs of estimated for RW2 under the same circumstances.

Thus while both alternatives offer adequate ways to ensure that the contemplated future regulatory standards can be met, MC9 offers the flexibility of implementing a lower-cost solution unless the high-cost solution is absolutely necessary.

## Conclusions

Based on the evaluations completed to date, it is clear that the City should undertake a large-volume, surface water diversion project that adds this water directly to the municipal water supply. The overall desirability of this solution is enhanced by inclusion of small-scale recycling and other small-project components. Because it ranked highest under the criteria used for this study, the project team recommends adoption of the strategy known in this report as MC9 for adoption. See the following chapter for a full explanation of the elements included in this alternative.

Even in the unlikely event of very stringent wastewater discharge standards in the future, the conclusion remains the same. Although the additional treatment costs required to meet such a standard would make alternative MC9 about equivalent in cost to zero-discharge alternative RW2, MC9 remains a better choice in terms of the other objectives. It would be easier to implement, more reliable and sustainable, and more supportive of quality of life in the region.

Alternatives MC7 and MC5 are also attractive alternatives and could be retained for further consideration. Our understanding of the differences in specific implications will continue to improve as we move toward implementation. The National Environmental Policy Act (NEPA) permitting process that lies ahead—regardless of the alternative selected—will require consideration of alternatives in addition to the preferred alternative.



## Chapter 6

# The Recommended Strategy

This chapter describes the top-ranked and recommended water resources management strategy, its costs and rate implications, and timing considerations. The project team developed these strategy recommendations based on the specifics of what is referred to in previous chapters as alternative MC9, the highest scoring of the 32 alternatives considered by this project, and to reflect public input and insights gained during the course of evaluation. The recommended strategy is comprised of two parts:

- A plan of action in the form of recommended projects for facilities development; pursuit of needed legislative, institutional, and regulatory changes; rate structure development; public involvement; and regional cooperation.
- Policies recommended for adoption as part of a Rank-Two Plan that focus water management on use of renewable resources and regional solutions consistent with the policy directives of the *Albuquerque/Bernalillo County Comprehensive Plan*. In this chapter, these policies follow an explanation of the projects that comprise the preferred alternative.

Figure 6-1 shows the make-up of the Albuquerque's water supply implied by the recommended strategy: use of nonrenewable ground-water supplies is replaced by a combination of conservation, use of the surface water the City owns, and recycling where feasible. This provides a safe and sustainable water supply to about 2040, when additional sources of supply are likely to be needed. This approach makes it possible to maintain a drought reserve that will prevent supply disruption or cost spikes during water-scarce years.

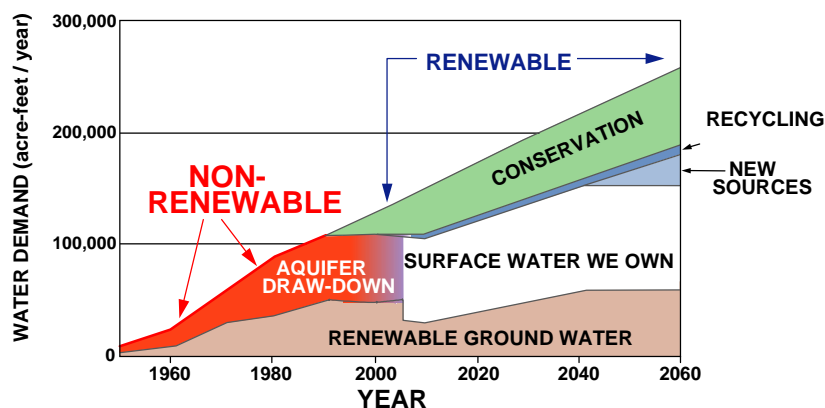


Figure Chapter 6 -1. Albuquerque's Future Water Supply

Figure 6-2 provides an overview of the structural projects required to implement the recommended strategy. These projects are described in general terms not only for the sake of brevity, but also because they still require development of specific siting plans and detailed design. The environmental studies and public input involved in the permitting process may cause some changes in the features of these projects. The recommended strategy, referred to earlier as Alternative MC9, comprises:

- A drinking water supply project that diverts, treats and distributes 97,000 ac-ft/yr of water from the Rio Grande, making full use of the surface water supplies the City already owns. About half the water will return to the City's Southside Water Reclamation Plant after use for treatment before being returned to the Rio Grande. This project includes
  - About 5 miles of subsurface infiltration galleries, which are similar to large French drains; this is the means for diverting water from the Rio Grande.
  - A water treatment plant to bring the water diverted from the river to drinking water standards.
  - Transmission pipelines to carry the water to users throughout the City's service area.
  - An aquifer storage and recovery (ASR) demonstration project at existing City wellfields. ASR technology makes it possible to store treated water underground and pump it back out through the same wells when needed. For Albuquerque, ASR has the potential to enable the City to stop its withdrawals from the Rio Grande whenever flow is low, supplementing regular ground-water supplies with treated surface water that has been temporarily stored underground.
- Constructed wetlands for recycling effluent from the City's Southside Water Reclamation Plant to provide irrigation for nearby parks and golf courses. As demand grows over time, this facility will be expanded to provide 3,900 acre-feet of water per year on a sustainable basis for nonpotable purposes in this area of the City.
- A project to enhance recharge and use shallow ground water for irrigation at the Albuquerque Zoo, the Biological Park, the Albuquerque Country Club, and other nearby public facilities. This project represents a first step toward developing cooperative agreements with the MRGCD, since some of the facilities used will be theirs. The project will supply 900 ac-ft/yr of water on a sustainable basis.
- Industrial wastewater recycling facilities in the North I-25 area using treated wastewater effluent from the Philips Semiconductor plant to supply local industrial process water needs and irrigation for Balloon Fiesta Park and other nearby turf irrigation uses. This project will eventually be augmented by surface water diverted from the Rio Grande through small-scale infiltration galleries to provide a total of 2,800 ac-ft/yr of water on a sustainable basis.

**Figure Chapter 6 -2. Recommended Strategy for Use of Existing Resources**

Carrying out the recommended strategy also requires efforts to deal with nonstructural elements, including work to:

- Define performance measures and guidelines for the establishment and maintenance of the drought reserve mentioned in the previous chapters.
- Conduct a rate study and adopt a new rate structure that fairly distributes the costs of providing a sustainable water supply and fosters conservation and wise water use.
- Pursue legislation to assure the City's continued ownership of water it stores underground. This is part of developing the ASR demonstration project.

- Continue study of Middle Rio Grande Valley hydrogeology to foster better understanding among all those involved of the consequences of water management policies and of the opportunities for regional action. The *Plan of Study* developed by the USGS provides a blueprint for action.
- Gain the cooperation of the MRGCD and neighboring jurisdictions to formulate and achieve adoption of a regional water management strategy using the guidelines provided by the Interstate Stream Commission for this purpose.
- Ensure that administrative rules and policies of the State Engineer take into account recent advances in our understanding of the aquifer and its hydrologic connection to the river.
- Continue and expand public involvement and public education programs that foster aquifer protection, conservation, sensible water practices and policies, and a better understanding of the community values that should be reflected in water policy.
- Provide coordination and additional support as needed for ground-water protection and conservation programs, so that these critical strategy elements continue to progress on schedule.

## Costs and Rate Implications

The projects outlined as the recommended strategy above imply total capital costs of about \$180 million and annual operating costs of about \$ 13.8 million. As mentioned in the previous chapter, changes in regulations could change the total costs involved, but the recommended strategy is to pursue immediately plans that effectively take into account likely future regulatory action and that have the flexibility to be adapted to cope with more stringent requirements if they are mandated.

Project phasing and the time required for permitting and design mean that not all the capital needs to be raised immediately. This will make it possible to gradually phase in required rate increases. A possible approach would be to increase rates by 9.4 percent in fiscal year (FY) 1999, and secure increases of 4.5 percent per year for the following 5 years. This is the equivalent of increasing the typical monthly residential water and sewer bill from about \$31.83 in 1998 to \$43.41 in 2005. Even with these rate increases, City of Albuquerque water rates will remain competitive with those of utilities in neighboring areas such as Rio Rancho and Paradise Hills.

A review of the costs and implications of continuing with the current practice of relying solely on local ground water shows that a “no-action” decision will be costly in the long run. Water rates will rise in the future, with or without implementation of the recommended strategy. Continuing the City’s past practice of using local ground water exclusively would require additional new wells costing about \$43 million and increased annual O&M costs of about \$4 million. Over the 60-year planning period, this amounts to a total increased cost of about \$106 million in net present worth terms.

Surface water use also reduces the future costs of complying with more stringent arsenic drinking water standards. Without the ability to use surface water, larger arsenic treatment facilities for ground water would be needed, requiring additional capital cost investments of between \$8 million and \$37 million, depending on the regulatory standards set, and up to \$3 million in average annual O&M costs. Additional capital and O&M costs over the planning period would have a total net present worth between \$14 and \$84 million.

The greatest costs of continuing past practices, however, are of two kinds:

- A clearly unsustainable approach to water supply places the health of the economy in doubt. Not only business decisions to expand or relocate, but the plans of public-sector agencies such as the Department of Defense can hinge on perceptions of sound planning for the future in water-short areas.
- More daunting still are the consequences of depleting the drought reserve and drawing water levels down below the subsidence threshold. This implies the possibility of curtailed water supplies during droughts and land subsidence. As water levels are severely depleted, the land surface settles (subsides), creating irregular depressions that permanently reduce the aquifer's ability to hold water and that destroy infrastructure and buildings. The calculations done as part of this project estimated the costs to be enormous, and not all the costs involved were included in the estimates because many are incalculable.

The project team estimates that the costs of failing to implement this Water Resources Management Strategy could easily amount to about \$200 million to \$275 million over the term of the proposed plan.

## Timing and Phasing

The project team believes that prompt action to develop renewable water supplies and the other aspects of the recommended strategy is essential for several reasons. First, about half of the water the City now pumps from the aquifer is not replenished. The aquifer's vulnerability increases as water tables continue to decline.

A second reason relates to the "use it or lose it" principle of western water law. In the water-scarce West, water and water rights that are being stored for future use are much less secure than those being actively used for municipal supply. Water that is not being put to "beneficial use" may be claimed by competing interests. Progress toward a well-defined project to make use of the City's surface water can only enhance the security of its water ownership.

Third, the large-scale projects that will do the most to shift the City to renewable supplies require lengthy and complex permitting processes that are subject to unforeseen delays. The City estimates that the major projects to divert, treat, and distribute surface water will come online in 2004. The many steps toward implementation are outlined in Chapter 7 of this *Summary Report*.

Small-scale projects, such as the North I-25 industrial water recycling and the Southside Water Reclamation Plant reuse projects, can be implemented without delay. The Public Works Department is integrating these projects into its plans. The first phase, the North I-25 industrial recycling project, could be in service in 1998.

Legislative initiatives to secure ownership of surface water the City stores underground have already begun, but enactment of this type of legislation involves complex issues covering situations that are much less clear-cut than is the case with ASR. Quick passage is not assured.

The timing of progress on regional initiatives to move toward better coordinated and more effective management of shared resources is difficult to predict. However, the move toward sustainability that the recommended strategy represents puts the City in a position to provide credible leadership. Implementing a clear strategy would provide momentum for regional progress.

## Recommendations

The recommended strategy entails many changes in the water policies that have guided water users in the Middle Rio Grande Valley since the 1950s and 1960s. The project team translated the insights gained from evaluating the many options open to the City into the following series of policy recommendations. These policies are intended to form part of a Rank II Plan and be integrated into efforts to implement the *Comprehensive Plan*.

The recommendations reflect both new knowledge of how the aquifer functions and a heightened awareness of the need for sustainability, regional considerations, and careful stewardship of water resources. The order in which the policies appear is not indicative of their priority. The recommendations will be developed into final policy statements by the City Council and the public over the ensuing months.

### Develop and Fully Use the City's Existing Surface Water Supplies

*The City of Albuquerque should proceed with dispatch to develop and fully use its San Juan-Chama and Rio Grande surface water as a direct water supply. It will move expeditiously to obtain the necessary funding and permits to construct the required projects. The water supply will be reliable and safe, fully protective of public health.*

As stated earlier, the City is now operating at a severe water deficit, drawing down the water table, and borrowing against our water future. The City owns surface water supplies—from the San Juan-Chama Diversion Project that was built in the 1960s and Rio Grande water rights—that can provide a renewable, sustainable supply to supplement the use of renewable ground-water supplies.

This approach will provide dependable, quality supplies as called for in the *Comprehensive Plan*. Sustainability is essential if the *Comprehensive Plan*'s other goals related to land use, environmental protection and heritage conservation, and community resource management are to be achieved.

Recent studies have provided a new understanding of how the aquifer functions. The result is that the San Juan-Chama Diversion Project supplies the City planned to leave in the Rio Grande to compensate for ground-water-pumping-induced losses to river flow must now be handled differently. This water, for which City customers pay nearly \$2 million per year, is suitable for treatment and distribution as part of the City's municipal supply. By implementing the recommended facilities development projects, the City will accomplish the *Comprehensive Plan*'s goal of "efficient water management and use."

As outlined in the *Comprehensive Plan*, "Existing water rights shall be protected." The City's existing Rio Grande and San Juan-Chama surface water rights cannot be used for municipal water supply as originally planned. The surface water simply will not seep into the aquifer in sufficient quantities to replenish pumping. As long as the surface water rights remain unused, they are more vulnerable to challenges from other water users in the water-scarce West. The City should preserve these rights by putting them to the use for which they were acquired.

Use of surface water will protect the aquifer and the Albuquerque community from the effects of overpumping ground water, and will provide a water supply system that is renewable in perpetuity.

## **Establish a Ground-Water Drought Reserve**

*The City should establish a ground-water drought reserve that maintains sufficient water in storage in the aquifer to provide water supply during a prolonged drought. Water levels in the aquifer need to be maintained so that a 10-year drought reserve would be accessible without causing adverse, irreversible impacts to the aquifer. Aquifer storage should be pursued to allow replenishment of the reserve.*

While surface water supplies have the advantage of being renewable, they are subject to interruption and scarcity. Because New Mexico experiences frequent droughts, a portion of the high-quality, easily accessible ground water stored in the aquifer should be maintained as a reserve. During times of water shortage, this will enable the City to provide an economical, uninterrupted water supply and to avoid depleting Rio Grande flows when they are below acceptable levels.

Ground water used as a drought supply has very high economic and quality-of-life value. Previous studies of the frequency and severity of droughts in the Southwest suggest that a 10-year drought reserve is prudent.

The drought reserve will also serve as a means of protecting the aquifer by focusing attention on the limited nature of supplies and the City's dependence on them. The "cushion" provided by the drought reserve prevents water levels being drawn down to near subsidence-threshold levels.

## **Support Regional Water Resources Planning and Management**

*The City should pursue efforts to enhance regional water resources planning and management activities within the Middle Rio Grande Valley. The City needs to work cooperatively with its neighbors—the Pueblos, the Middle Rio Grande Conservancy District, middle valley cities and counties, and involved state and federal agencies. The City should become proactively involved in and monitor the progress of regional water management initiatives that may affect the City and the region.*

The aquifer and the Rio Grande are resources shared and preserved by many users throughout the Albuquerque basin and beyond. The City recognizes that good water management practice requires a regional approach that makes coordination and cooperation among the many jurisdictions involved possible. As the largest single user of the aquifer, the City recognizes the leadership role it must play. Development of the Water Resources Management Strategy project is just one example of proactive, regionally aware action the City is taking.

In developing the recommended water resources strategy, the City used a process consistent with the State's *Regional Water Planning Handbook* (Interstate Stream Commission, 1994). The regional planning process should now be extended to include other water users in the region. Regional planning should address uses for public and domestic water supply, irrigated agriculture, livestock, commercial, industrial, and fish, wildlife and recreation. The City, neighboring jurisdictions, and other water users will need to work with state and regional agencies with water management responsibilities.

This recommendation involves three elements, outlined below.

### **Continue and Expand Technical Investigations in the Middle Rio Grande Valley**

*The City should continue its proactive role to ensure that the necessary investigations are completed efficiently and expeditiously, and that they result in the use of an improved quantitative model for water rights administration within the middle valley.*

Effective regional water resources planning and management requires a clear understanding of hydrologic conditions. Our knowledge of the aquifer and the aquifer-river connection is vastly improved over what it was 10 years ago because the City took the initiative to begin critical studies. More remains to be learned. In addition, because human uses are causing rapid changes in the hydrologic system, ongoing study and monitoring are required to remain current with trends, conditions, and the consequences of water management practices.

The investigations necessary to improve the quantification of the water resources of the region and the connection between the surface and ground-water systems have been identified in the *Plan of Study to Quantify the Hydrologic Relations Between the Rio Grande and the Santa Fe Group Aquifer System Near Albuquerque, Central New Mexico* (USGS, 1996). An executive summary of this study appears in the appendices to this Summary Report.

### **Seek to Adopt a Regional Water Management Strategy**

*The City is aware of the need to seek common solutions within a regional context. The City should seek to work cooperatively with others in the middle valley to establish a framework for coordinated water resources management. The framework needs to allow for the fair participation and representation of the interests of the public; domestic, municipal, industrial, and agricultural water users; and environmental and riparian and riverine corridor uses.*

The City recognizes that its planning cannot occur in isolation. In addition to fostering the technical investigations described above, issues requiring attention include water conservation, reclamation, and reuse; an inclusive public process to determine acceptable tradeoffs among urban, agricultural, and riparian water needs; equitable sharing of costs and benefits; appropriate use and regulation of domestic wells; preservation and enhancement of aquifer recharge through land-use planning; maintenance and enhancement of the existing irrigation canal and drain system; management of flood waters; and development of aquifer storage and recovery capabilities.

### **Modify and Improve the Accuracy and Efficiency of Administration of Water Rights in the Middle Valley**

*The City needs to work with the State Engineer Office to facilitate, support, and encourage the adoption of improved methods of estimating river depletions within the middle valley. The City should support and pursue the adoption of legislation where necessary and appropriate to secure its rights and to improve the efficiency of water resources management in the region.*

Improved accuracy and efficiency in the administration of water rights and the management of water resources in the middle valley is to the benefit of everyone within the region. Achieving these benefits will require a significant effort because of the far-reaching implications of the new USGS aquifer model and the dramatically different picture it represents of aquifer recharge.

The SEO's determination of how much water Albuquerque must put into the Rio Grande will have a major impact on water management practices and costs. The Public Works Department has maintained a dialog with the SEO regarding study findings and implications throughout the course of the Water Resources Management Strategy project. The SEO is following the progress of work to confirm the accuracy and implications of recent studies.

## **Pursue the Conjunctive Use of Available Water Resources**

*The City should enhance the sustainability of the water supply by effectively combining the use of surface water, reclaimed water, and shallow and deep ground water. The City will seek to match the various qualities of water available with the water quality required for specific uses.*

Enhancing the efficiency of the City's water use, as called for in the *Comprehensive Plan*, requires conjunctive management and use of all available resources: surface water for municipal and industrial supply and for irrigation, as well as use of lower-quality shallow ground water for irrigation and other nonpotable uses. Reclamation and reuse of existing water supplies, where economically feasible and protective of human health and the environment, represent viable methods of increasing the usefulness of a limited water supply.

This recommendation involves the following three elements.

- Use reclaimed wastewater, surface water, and shallow ground water for irrigation and nonpotable uses.
- Favor reclaimed water use.
- Use a combination of surface water and deep aquifer ground water for municipal and industrial supply.

### **Use Reclaimed Wastewater, Surface Water, and Shallow Ground Water for Irrigation and Nonpotable Uses**

*To the extent practicable, it would be wise to eliminate the use of high-quality water from the deep aquifer for irrigation of parks, golf courses, and other large turf applications. Use reclaimed wastewater, surface water, and shallow ground water for irrigation and nonpotable uses. Use of shallow ground water will need to be augmented with enhanced recharge as necessary to protect shallow ground-water levels.*

The water quality of reclaimed wastewater, surface water, and portions of the shallow ground-water system, though generally not adequate for use as a drinking water supply without additional treatment, is well suited for irrigation and some industrial uses. Shallow ground-water use must be accompanied by enhanced recharge to avoid harmful water-level declines.

### **Favor Reclaimed Water Use**

*The City should favor the use of reclaimed water where economically feasible and protective of human health and the environment. The City will need to take action to ensure the appropriate use of nonpotable supplies to meet nonpotable needs. This may include providing economic incentives as necessary to encourage the use of reclaimed water.*

Reclaimed water from industrial and municipal effluent sources can be an economically feasible alternative to the use of deep aquifer pumping to meet industrial and irrigation demands, which do not require drinking water quality sources. However, sufficient treatment must be provided to protect public health and the environment. Consideration must also be given to satisfying the return flow needs of the Rio Grande from both water rights and environmental standpoints.

## **Use Surface Water and Deep Aquifer Ground Water Conjunctively for Municipal and Industrial Supply**

*The City should develop the new facilities needed to efficiently and fully use the City's San Juan-Chama and Rio Grande surface water for drinking water supply. Pumping from the deep aquifer should be focused on meeting seasonal peak demands and as a drought reserve. Methods to store available surface water in the aquifer and to recover it from storage will be needed.*

The use of ground water will always be a major component of the City's supply system. Using the City's surface water for municipal and industrial supply will protect the aquifer so that it is available to meet seasonal peak demands and as a drought reserve. Without a ground-water supply, the City would need extremely expensive surface water storage facilities and larger and more costly treatment facilities to meet seasonal peak demands.

Successfully establishing and preserving a drought reserve requires that water withdrawn from the aquifer during times of drought be replenished during times of above average water availability. In Albuquerque, this requires artificial recharge of the aquifer with deep recharge wells. It is essential that this capability be developed and demonstrated.

## **Pursue Acquisition of New Water Supplies as Needed**

*The City should pursue a portfolio of potential additional sources of supply. This will need to entail legal and institutional changes to provide for short-term leases and long-term acquisition of rights and supplies. Full consideration will be given to the regional context.*

The *Comprehensive Plan* calls for new water rights to be acquired if necessary to accommodate increasing needs. As the chart at the beginning of this chapter shows, in the future additional supplies will be needed, even if the City is successful in meeting conservation goals and fully utilizing renewable resources. The community leaders who secured San Juan-Chama water for Albuquerque had the foresight to see that competition for water was becoming stronger, and they took action to ensure that we would have adequate supplies. The cost of obtaining the equivalent of the City's San Juan-Chama water today would be very large. The City should continue its tradition of foresight in water matters.

The legal and physical availability of water supplies depends on a number of extremely complex and difficult issues that need to be resolved. Resolution of these issues will need to involve others within the region. A long timeline can be expected for obtaining substantial new supplies.

## **Fully Implement the Water Conservation Strategy**

*The City needs to take the necessary steps to fully achieve its adopted water conservation goal to reduce per capita use of 30 percent by 2004 compared to the base period average of 250 gallons per person per day.*

*In addition to the ongoing programs providing significant resources to reduce water use, the City's water resources and conservation programs will need to address State evaluation criteria by providing: (1) public education regarding the need and methods for conserving, (2) metering of all City water uses, (3) accounting for different types of uses (residential, commercial, etc.) and comparison of amounts of use to western norms, and (4) drought contingency plans.*

The City and its water customers have made great strides in the early years of their conservation efforts. The Public Works Department estimates that ratepayers conserved about 6 billion gallons (about 18,000 acre-feet) in 1996. Continuing progress is needed and full attainment of the goals established is needed. Water conservation is required by the City's adopted water conservation strategy (Enactment No. 40-1995).

Successful implementation of the conservation program is a foundation for the recommended Water Resources Management Strategy. In addition to representing wise management and stewardship of the water resources, successful implementation of an effective conservation program is by State law a regulatory prerequisite for obtaining the permits the City will require to pursue any water program.

## **Fully Implement the Ground-Water Protection Policy and Action Plan**

*The City should take steps to fully implement the Ground-Water Protection Policy and Action Plan. Prevention of future contamination, protection of aquifer recharge areas, and the remediation of existing ground-water contamination will be areas of special emphasis and high priority.*

The Albuquerque/Bernalillo County Ground-Water Protection Policy and Action Plan (County Resolution No. AR 121-93 and City Enactment No. 81-1994) is another cornerstone of the recommended strategy. The early stages of implementation are under way, but much progress remains to achieve full implementation.

Regardless of the amount of surface water used, the ground-water system is essential for water supply and as a drought reserve. Properly managed, Albuquerque's ground-water supplies constitute a high-quality, low-cost, permanently renewable water source. Protecting the ground water from contamination is of paramount importance.

We now know that the extent of the productive aquifer is smaller than earlier studies suggested. Most recharge of the deep aquifer system occurs through the shallow ground-water system in the inner valley, much of which is contaminated. Contamination located in areas where water flows relatively quickly to the deep aquifer (called "recharge windows") is being transported toward public water supply wells. These conditions must be addressed or the viability of the ground-water component of the supply is imperiled.

## **Equitably Incorporate the Costs of Providing a Safe and Sustainable Water Supply into Water Rates**

*The City should develop an equitable water rate structure that provides a stable and predictable revenue stream sufficient to cover operating and capital replacement costs, as well as finance system expansion and acquisition of new water supplies. The rates and fees will be designed to encourage conservation. Necessary rate increases will be gradual to the extent possible. Provisions will be made to assure that low-income individuals continue to receive affordable basic water and wastewater services.*

As called for in the *Comprehensive Plan* and the Ground-Water Protection Policy, rates and fees should be designed to reflect the true cost of obtaining and protecting the water supplied to customers. The *Value of Water* (Brown et al, 1996) study confirmed the need for water prices to reflect its true value in order to prevent waste.

The increases required to implement the recommended water resources strategy are not minor, but neither are they unaffordable. Assuring a safe and sustainable water supply is economically feasible. These costs should be equitably shared, and the impact of rates on customers should be fair, and recognize that high-volume uses are not necessarily bad or wasteful. For example, large families use more water than small ones, even though their per capita use may be the same.

Consideration should be given to the life-cycle costs of the project, the degree to which existing water resources are utilized, and potential savings to customers that accompany wise resource management. Costs related to arsenic treatment needs or the avoidance of drought effects and land surface subsidence will be much greater if this strategy is not implemented.

## **Protect Valued Environmental Resources**

*As the City moves to implement its use of existing water resources, it will be necessary to take steps to protect valued environmental resources of the region, including both the shallow and deep aquifer; the bosque and valley; the Rio Grande stream system; and recreational, historical, and cultural values. In every implementation phase, the City should consider impacts on environmental resources and take appropriate steps to mitigate unavoidable damage.*

The City's San Juan-Chama and Rio Grande water can be used to meet municipal and industrial needs without jeopardizing valued environmental resources. The bosque, the river, and the plants and wildlife that live in them are important aspects of the quality of life and environmental health of Albuquerque. These and other environmental resources can be protected—and in some cases enhanced—at the same time that we develop needed water supplies.

The “environmental” argument in favor of implementing the recommended strategy is in no way a minor one: switching to use of renewable resources is the single most important action that can be taken to protect the aquifer and to avoid land surface subsidence and other ill effects of overpumping.

## **Preserve and Enhance the Quality of Life in the Region**

*The City seeks a Water Resources Management Strategy that will preserve and enhance the quality of life within the region. The implementation of the strategy will need to include support of infrastructure needs (basic water and wastewater services) and public amenities (parks, greenbelts, etc.). In addition, the benefits and costs of implementation will be shared equitably—among current and future residents of the region.*

As the largest population center in the state, Albuquerque recognizes its obligation to continue to enhance the quality of life within the region. City parks, commercial activity, sources of employment, recreational opportunities, and functioning infrastructure systems are all key factors influencing quality of life. They are the building blocks of a healthy economy and ongoing development, and all residents benefit from them.

## **Encourage and Facilitate Public Involvement and Support**

*The City intends to keep the public informed about the choices and tradeoffs involved in making water management decisions and will invite public comment and participation in implementation of these policies.*

As water consumers and ratepayers, the entire population of Albuquerque is affected by the water resources program, which they rely on for safe and sustainable supplies. Conservation and aquifer protection goals cannot be met without an informed and aware public. By the same token, water resources development requires an educated public that understands the tradeoffs involved in water decisions and the importance of sound planning.

Understanding the best options for water supply and other services requires providing channels for meaningful communication of community values and preferences. The Water Resources Management Strategy project has had a very productive dialog with the stakeholders of many kinds in the course of the project. Continuing public involvement and participation are essential elements of moving forward toward a secure water future.

## **Update the City/County Comprehensive Plan and Other City Plans**

*After public review and adoption by the City Council, and where applicable, the Albuquerque/Bernalillo County Comprehensive Plan and/or other Rank plans should be amended to reflect the Albuquerque Water Resources Management Strategy. The Water Resources Management Strategy should also be updated as necessary.*

Integration of plans for water resource management and other functions and policies is key to accomplishing the goals they set forth. The changes affecting water resources management will continue to be important: major regulatory and administrative decisions are pending and our technical understanding of the middle valley's water systems will continue to develop. The water resources management strategy must reflect the dynamic nature of water issues, federal and state regulations, and the emerging and changing technical understanding of the available resources.

Adoption of the recommendations will provide the foundation for ongoing development of sensible water policies that benefit the Albuquerque community and the region. These policy directives will provide a sense of direction for successfully confronting future, as yet unforeseen challenges.

The following chapter reviews the steps involved in implementing the recommended strategy.



# Chapter 7

## Implementation Plan

This chapter outlines the activities required to implement the recommended strategy. The five primary areas of activity are:

- Public involvement
- Selection of sites for the project facilities
- Rate study and design
- Permitting, design, and construction of the drinking water supply project
- Early implementation of the reclamation and reuse projects
- Continuation and expansion of regional planning efforts

The schedule shown in Figure 7-1 indicates the overall timeline anticipated and the points at which City Council approval is required to move forward.

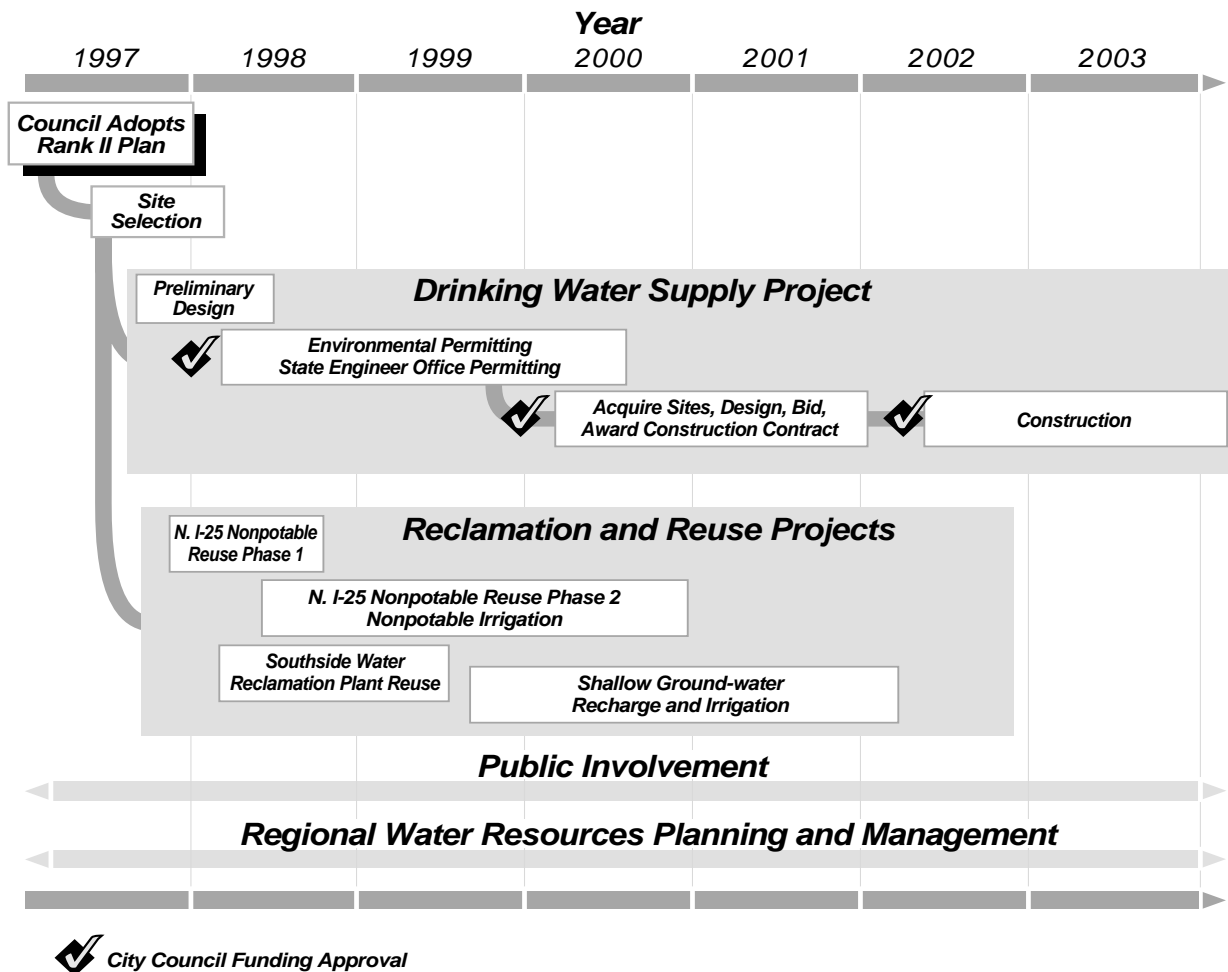


Figure Chapter 7 -1. Planned Implementation Schedule

## Public Involvement

The public involvement program developed for the water resources management planning process will be continued. It will continue to seek the advice and counsel of the Customers Advisory Committee and to engage the public and elected officials in the region in the ongoing planning and decisionmaking process.

Public education opportunities will also be incorporated into projects where appropriate. For example, the planned water treatment pilot facility, which will test treatment methods to ensure the best is chosen for final design, will include public access and education features. Recycling projects also provide excellent opportunities for demonstrating water resources and environmental principles.

## Site Selection

The recommended strategy does not include locations for the proposed facilities. The next step is to identify potential sites that would be appropriate and evaluate which are best. This includes rights-of-way considerations, coordination with the MRGCD, and evaluation of the sites in accordance with the five criteria used throughout the evaluation process.

Completion of site selection requires public review and comment on the potential sites and their strengths and weaknesses, and—once approval is obtained—purchase of land, rights-of-way and easements.

## Rate Study and Design

As mentioned in Chapter 6, the recommended strategy calls for phasing in needed rate increases over a 6-year period, beginning in fiscal year 1999. Required increases are estimated to be around a 9.4 percent in 1999 and 4.5 percent per year for the following 5 years. These figures assume 25 percent cash financing with revenue bonds covering the remaining costs. The estimated increases represent incremental funding needs for the recommended projects and initiatives, but do not include costs for currently funded activities or other potential future needs.

Before instituting any increases, a rate study and design project is needed to plan financial needs and potential revenues more precisely than was possible under the scope of this project. Rate design will also involve consensus building on equitable ways to share the rate burden, provide protection for low-income water users, set appropriate impact fees and commodity charges, and create conservation incentives, among other issues.

## Drinking Water Supply Projects Implementation

Implementing the major surface water supply projects, which include infiltration galleries, a treatment plant, and transmission pipelines, involves:

- Working closely with the MRGCD to determine appropriate project design, any mitigation measures needed, and an equitable access agreement.
- Preliminary design, consisting of studies and testing to ensure that the engineering concepts used in design will work as planned. Hydraulic, hydrologic, water quality and geotechnical tests must be conducted, among others. Pilot-scale water treatment processes and infiltration galleries will also be needed to ensure full understanding of localized conditions.

- Environmental permitting will include compliance with the NEPA (National Environmental Policy Act) process, which provides a thorough, structured way of investigating, seeking public comment on, and evaluating potential environmental impacts. Preparing an environmental impact statement (EIS) is part of the NEPA process, as is maintaining consideration of alternatives, including a “no-action” alternative. Concerns regarding endangered species may create the need for a Biological Assessment to be conducted. These activities generate the information and dialog needed for fine-tuning project ideas and plans. Necessary federal permits may include a Water Quality Certification that the project will not violate state or federal water quality standards and a Dredge and Fill Permit.
- State Engineer Office permitting requires preparing a request for authorization to divert surface water and showing proper calculation of the water rights and plans to properly administer the project. The State Engineer reviews this application and submits it for public review. If protests are filed, the State Engineer presides over a hearing and decides the issues raised.
- Design and construction will proceed in accordance with standard City competitive practices. Design is finalized after all permits and approvals have been obtained.
- Aquifer storage and recovery demonstration project will involve not only permitting, but also drafting and seeking passage of legislation that would secure ownership of water stored underground. This lack of secure ownership is one of the roadblocks to aquifer storage, which otherwise appears promising. This project will provide an opportunity for experimenting with this technology and educating water professionals and others.

## Reclamation and Reuse Projects

### Recycling Projects

Early implementation of recycling projects offers the potential for creating operational information that may be useful in the permitting and final design of the large drinking water projects. The Public Works Department is therefore beginning to integrate the recommended strategy’s recycling projects into its work plans now.

The North I-25 project will be constructed in phases: the first phase will recycle wastewater from Philips Semiconductors and other local industries for industrial uses and irrigation needs at Balloon Fiesta Park. The second phase will add surface water diverted through infiltration galleries and additional reclaimed water to provide nonpotable water to large turf areas in the Northeast Heights.

Phase 1 activities will be similar to those for the water supply project, but on a smaller and simpler scale. The necessary steps include preliminary design, pursuit of federal funding for water reuse from the USBR (including preparing an EIS), final design, and construction.

The constructed wetlands project at the Southside Water Reclamation Plant will also be implemented in two phases. The first phase will supply existing local turf irrigation needs; the second phase will expand facilities. In addition to the steps mentioned for the North I-25 project, this phase will require a state ground-water discharge permit.

## **Shallow Ground-Water Irrigation Project**

The shallow ground-water project for providing irrigation water in the central valley area will provide a small-scale step toward regional cooperation. It will involve close coordination with the MRGCD to work out operational and institutional issues associated with enhanced recharge using MRGCD canals and drains.

Other activities will include working with potential irrigator-customers to assist the transition from deep aquifer supplies to shallow ground water; applying for and obtaining a SEO diversion permit; and preliminary and final design, construction contract bidding, and construction.

## **Regional Water Resources Planning**

Initial activities required to continue the regional planning process include the following:

- Develop agreements with neighboring jurisdictions and ground-water users to define the regional planning objectives and process. Pursue state funding assistance for regional water planning.
- Carry out technical investigations to better define the region's water resources, the connection between the river and the aquifer, and performance measures for establishment of a drought reserve.
- Work with the participating jurisdictions and the SEO to update the administration of water rights within the middle valley to reflect the physical workings of the hydrologic system.
- Evaluate the need for additional sources of short-term and long-term supply as the administrative and technical issues begin to be resolved. Assess the actual quantities of water that will be required and available in the future. Examine flexibility that could be exercised by the federal water managers for operation of existing facilities on the Rio Grande. Evaluate the ability to exchange, transfer, or lease water from existing water uses using water-bank concepts or other means. Consider the economic, technical, environmental, and institutional/legal feasibility related to developing the various alternatives or new sources.
- Become involved in and monitor the progress of regional water management initiatives and recovery programs for endangered species.
- Pursue and acquire additional water supply sources as appropriate.

The project team recommends that these implementation activities begin as soon as Council approval is obtained for a new Water Resources Management Strategy.

## Chapter 8

# References

Brown, F.L., S.C. Nunn, J.W. Shomaker, and G. Woodward. 1996. *The Value of Water*. Prepared for the City of Albuquerque.

Camp Dresser & McKee. 1996. *Industrial Waste Reclamation and Recharge Feasibility Study Report*. Prepared for City of Albuquerque in cooperation with CH2M HILL. January.

Camp Dresser & McKee. 1995. *Reclamation and Recharge Feasibility Study Report*. Prepared for City of Albuquerque.

CH2M HILL. 1997a. *Albuquerque Water Resources Management Strategy, Evaluation of Alternatives and Strategy Formulation: The Technical Basis of the Recommended Strategy*. Prepared for City of Albuquerque.

CH2M HILL. 1997b. *Albuquerque Water Resources Management Strategy, Alternative Descriptions and Opinions of Cost*. Prepared for City of Albuquerque.

CH2M HILL. 1997c. *Albuquerque Water Resources Management Strategy, Preliminary Evaluation of Environmental Consequences*. Prepared for City of Albuquerque.

CH2M HILL. 1997d. *Albuquerque Water Resources Management Strategy, Ground-Water Modeling Documentation*. Prepared for City of Albuquerque.

CH2M HILL. 1995. *Albuquerque Water Resources Management Strategy, San Juan-Chama Diversion Project Options*. Prepared for City of Albuquerque. July.

Crawford, C.S., A.C. Cully, R. Leutheuser, M.S. Sifuentes, L.H. White, and J.P. Wilber. 1993. *Middle Rio Grande Ecosystem: Bosque Biological Management Plan*.

New Mexico Bureau of Mines and Mineral Resources. 1992. *Hydrogeologic Framework of the Northern Albuquerque Basin*. Administrative report to Department of Public Works, Water Utility Division, City of Albuquerque.

New Mexico Interstate Stream Commission. 1994. *Regional Water Planning Handbook*.

U.S. Bureau of Reclamation. 1997. *Middle Rio Grande Water Assessment*. Prepared in cooperation with the City of Albuquerque Public Works Department.

U.S. Geological Survey. 1996. *Plan of Study to Quantify the Hydrologic Relations Between the Rio Grande and the Santa Fe Group Aquifer System Near Albuquerque, Central New Mexico*. Water Resources Investigations Report 96-4006. Prepared in cooperation with the City of Albuquerque Public Works Department.

U.S. Geological Survey. 1995. *Simulation of Ground-Water Flow in the Albuquerque Basin, Central New Mexico, 1901-1994, With Projections to 2020*. Water-Resources Investigations Report 94-4251. Prepared in cooperation with the City of Albuquerque Public Works Department.

U.S. Geological Survey. 1993. *Geohydrologic Framework and Hydrologic Conditions in the Albuquerque Basin, Central New Mexico*. Water-Resources Investigations Report 93-4149. Prepared in cooperation with the City of Albuquerque Public Works Department, Water Utility Division.

# Appendix E

## Summary of Public Involvement

This appendix summarizes the public involvement activities carried out as part of the Water Resources Management Strategy project, with emphasis on Phase 2 activities related to evaluating alternative water strategies and formulating final recommendations. Public involvement included community outreach and education activities, feedback mechanisms addressing specific aspects of the project, a Customers Advisory Committee, media relations, and meetings and special events such as field trips designed to enable participants in the decisionmaking process to see first-hand the planning elements involved.

The City has sought to design a strategy that reflects community values and an awareness of Albuquerque's leadership role in the region. These goals, together with the public process required for strategy adoption and implementation, dictated that both areas of broad consensus and critical roadblocks to acceptance be identified early in the planning process.

Albuquerque residents' positive response to earlier ground-water protection and conservation efforts were indicators that both the public at large and a wide array of special interest groups are sensitive to the importance of water issues. A new water strategy for Albuquerque would, in fact, affect every resident through its impacts on rates, the environment, water availability for public amenities such as parks, and the area's economic health.

Overall, the City's goal was to facilitate public involvement adequate to ensure broad understanding and acceptance of water resources activities. The specific goals for its public involvement program set forth at the beginning of the project focused on providing:

- Two-way channels of communication appropriate for all identified stakeholder groups.
- Documentation of stakeholder outreach and input.
- Means for determining public attitudes and preferences about water resources options.
- Informational materials to disseminate ideas and dispel misconceptions, spur the interest and involvement of decisionmakers, foster consistent messages about water programs, and inform ratepayers of the purpose of and need for the Water Resources Management Strategy project.
- Mechanisms for building consensus and gaining support for adoption of a consensus-supported plan.

## Phase 1 Recap

The public involvement plan for the project was devised at the beginning of Phase 1, and was documented in a *Staff Guidebook*, which was updated at the beginning of Phase 2. Phase 2 activities built on and continued with Phase 1 activities. The initial program plan defined the goals set forth above, identified more than 80 key stakeholder groups and

organizations, set forth core messages to be communicated, and delineated the roles that different project team members would play.

Most of the mechanisms to be used for public involvement were also set in Phase 1. These included as basic activities:

- Establishing and maintaining a **database of interested parties** that would make it possible to mail targeted information to a variety of categories of stakeholders.
- Establishing and responding to calls to a **Water Resources Information Line** telephone number that was published in all public project documents and announcements.
- Periodic **open forums** of two types: one targeted to the general public and policy issues and one targeted to a more technically oriented audience of regulators, agency officials, water engineers and lawyers, and other members of the public with a longstanding interest in water issues. Each forum included a written feedback mechanism designed to enable attendees to address the issues that constituted the focus of the forum and to provide the City with a better understanding of the views and values that should be reflected in water policy.
- **Stakeholder interviews and meetings** focusing on one-on-one or small-group discussion with those likely to influence the course of water policy and practices, including community leaders, regulatory and water agency officials, representatives of neighboring jurisdictions, Pueblo leaders, elected officials, and others.
- Community outreach through **presentations to any community group expressing an interest**, such as the League of Women Voters, neighborhood associations, and special interest groups focusing on environmental, economic development, or other issues. This outreach also included talks to trade associations for engineers and water professionals and to an informal group of more than 30 water utility and regulatory professionals who have met regularly to exchange ideas and perspectives.
- **Interaction with the media** that has included editorial board briefings, background briefings for reporters, and interviews.
- Production and **prime-time television broadcast of two 30-minute programs** on conservation and water resources issues has also played a key role in public outreach and education. The first two videos formed part of the City's water conservation program and preceded Phase 2. About 1,500 full-length and edited copies of these videos were provided to public libraries, educators, community leaders, and others requesting them.
- The need for a **Customers Advisory Committee** representing a wide spectrum of public opinion was identified in Phase 1.
- Preparation and distribution of **informational materials** explaining in easily understood terms the key issues at stake, the history of water policy and practices, water resources planning activities, and the alternatives under consideration.

Near the beginning of Phase 1, the project team interviewed 15 people thought to represent the range of opinion on water issues. Those interviewed included:

- William deBuys, New Mexico Representative of the Conservation Fund; Editor, *Common Ground* magazine; member, Bosque Task Force
- Dod Spiker, President, League of Neighborhood Associations
- Tom Swisstack, Mayor, and Harold Donovan, City Administrator, City of Rio Rancho
- Don Hutchinson, Central Operations Manager, Intel Corporation, Rio Rancho facility
- Chris Shuey, Director, Community Water, Wastes and Toxics Program, Southwest Research and Information Center
- Jeff Whitney, U.S. Fish and Wildlife Service, federal agencies coordinator for the Bosque Task Force
- Sam Cummins, Manager (Retired), Water Utility Division, City of Albuquerque Department of Public Works
- Jose Otero, Board member, Middle Rio Grande Conservancy District; farmer in the Peralta area
- Carolyn Abeita, administrative law attorney for the 10 southern Pueblos, Council of Tribal Governments
- Al Utton, Former Chairman, Interstate Stream Commission; Director, Transboundary Resource Center, University of New Mexico School of Law
- Miguel Garcia, Chairperson, South Valley Action Coalition
- Jean Rogers, community activist in the South Valley area; spearheaded the initiative campaign to establish southern Bernalillo County as a separate county
- Bob Gurulé, Director, City of Albuquerque Department of Public Works
- Gary Tonjes, President, Albuquerque Economic Development, Inc.
- Malcolm Fleming, Division Director, Community Services, and Richard Bruselas, Director, Environmental Health Department, Bernalillo County

Interviewees were first asked to divide 15 objectives for water strategy into high, medium, and low priority categories. Then they were asked to discuss what measures of performance would be relevant for each objective, and if any major objectives were missing.

The most highly ranked objectives were: protecting the aquifer; ensuring a sustainable supply; ensuring the highest quality water; and providing for potential long-term needs. Most interviewees found it difficult to settle on a final grouping of priorities and to define exact performance measures. Several mentioned that a lack of consistent measurement practices was one of the main roadblocks to more regional cooperation and understanding.

These interviews gave the project team a good preliminary look at issues, potential evaluation criteria and performance measures, and areas of consensus and disagreement. Interviewees were in strong agreement regarding the need to protect the aquifer and to

achieve a sustainable water supply, although their definitions of sustainability varied widely. This has held true for a wider public throughout Phase 2.

A report on these interviews forms part of the project documentation for Phase 1.

## Customers Advisory Committee

The project team recognized the need for a representative group of ratepayers who could maintain an in-depth dialog on community interests in the water resources planning process. Near the beginning of Phase 2, the Mayor proposed a committee, and the City Council passed Council Bill R-31 Enactment No. 36-1996 appointing a 10-member Customers' Advisory Committee (CAC) to fulfill this function and advise the project staff, the Mayor and the Council. CAC members are:

- Vickie Gabin, Sierra Club, Chair
- Norman Churchill, League of Neighborhoods, East Side, Vice-Chair
- Bobbi Altman, League of Neighborhoods, West Side
- Charles Barnhart, Albuquerque Economic Forum
- Aileen Gatterman, League of Women Voters
- William Brooks Gauert, League of Neighborhoods
- Hector Gonzales, Unincorporated Bernalillo County
- Carlo Lucero, Hispano Chamber of Commerce
- Bill Mairson, Shared Vision - Environmental Caucus
- Jim Morris, Greater Albuquerque Chamber of Commerce

The CAC met more than 20 times between June 1996 and February 1997. All regular meetings were open to the public and were posted and conducted in accordance with the Open Meetings Act. Each meeting included a period for public comment.

The project team first brought the Committee up to date on work in progress. Subsequent meetings continued discussion of work as it progressed and allowed CAC member comment and input on criteria formulation, alternatives scoring, and weighting schemes for the evaluation process, among other topics. Meetings also included speakers such as the State Engineer Tom Turney, Steve Hansen (U.S. Bureau of Reclamation water resources specialist), and Frank Titus (science advisor to the State Engineer). The project team prepared meeting minutes recording these discussions, which form part of the project documentation.

The committee members acquainted themselves with local water and wastewater systems during a field trip that included some of the City's existing water facilities, some of the Middle Rio Grande Conservancy District (MRGCD) facilities, the Southside Water Reclamation Plant and outfall, and other elements considered in water planning. They also read many project documents and other background materials.

CAC members discussed and commented on the recommended strategy, technical memoranda and other documents that form part of the project deliverables. CAC members attended and spoke at the Regional and Technical Forums held during Phase 2 to gather public comment on preliminary alternatives rankings.

A written report from the CAC accompanied the project team's strategy recommendations to the Mayor, and the CAC reported to the Council regarding their participation and views

on the recommended strategy. A statement of the CAC's position regarding the recommended strategy appears as an appendix to the Mayor's proposed *Water Resources Management Strategy*.

CAC members also spoke to groups they represented and others regarding the importance of the water resources planning process and project progress.

The CAC's advisory contribution has been significant, and their input has shaped the recommended policies. The City proposes to continue the CAC's term through the implementation phases of the project, although the meeting schedule will abate somewhat after recommendations have been heard and acted on.

## City Staff Steering Committee

A change in water resources strategy will affect the plans and work of other City departments, several of which take water resources issues into account in carrying out their duties. For this reason, and to foster integration of City plans covering different functional areas, the project team formed a City Staff Steering Committee that reviewed and commented on project work as it progressed.

Like the Customers Advisory Committee, the Staff Steering Committee brought new perspective to the project team. They reviewed technical memoranda prepared as part of the project, participated in criteria development and alternatives evaluation, and ensured that strategy elements were consistent with other ongoing departmental plans.

Committee participants included:

- Stephen Bockemeier, Finance Division, Public Works Department
- Charles Bowman, Wastewater Utility Division, Public Works Department
- John Castillo, Public Works Department
- Lou Columbo, Council Services
- Gary Daves, Water Rights, Public Works Department
- Sandy Doyle, Finance Division, Public Works Department
- Bob Hogrefe, Wastewater Utility Division, Public Works Department
- Bob Hume, Water Utility Division, Public Works Department
- Ondrea Lindereth, Open Space, Design and Development
- Curt Montman, Environmental Health Department
- Greg Olson, Utility Development Division, Public Works Department
- Ted Pearson, Legal Department
- Roy Robinson, Water Utility Division, Public Works Department
- Gerald Romero, Office of Management & Budget, Mayor's Office
- Myra Segal, Council Services
- Tom Shoemaker, Water Utility Division, Public Works Department
- Art Stuart, Water Utility Division, Public Works Department
- Jean Witherspoon, Water Conservation, Public Works Department
- Shirley Wozniak, Planning Department

## Public Forums and Community Meetings

The Public Works Department sponsored and presented a series of three advertised regional and technical forums. These were pairs of open public meetings held in the evenings, with a “regional” forum focusing on the general public held one evening followed by a “technical” forum geared to a more technical audience the following evening. In practice the audience was mixed for both, and all invitations advertised both forums. The final forum on the recommended strategy was held only once.

The City mailed invitations to about 400 people on the interested parties database, including local and regional community leaders and officials, water professionals serving both the public and private sectors, neighborhood association presidents, news media, Pueblo leaders, and others. In addition, the forums were posted as required for official public meetings and advertised in the local newspapers and through flyers posted throughout the City /County Administration Building. The forums received positive coverage in the *Albuquerque Journal* and the *Tribune*.

At each forum, the project team made a major presentation of work completed and findings to date, conducted a question-and-answer period with the audience, provided a variety of informational materials, and requested that participants complete a written feedback form designed specifically for the forum.

### Summer 1995 Forum

In August 1995, citizens and officials commented on the initial assessment of the water supply, demands, preliminary options, and legal and institutional issues. A total of about 90 people attended these first forums, many of them water professionals or citizens with a longstanding interest in water issues.

The feedback form for this forum asked about the priorities and objectives the participants had for water supply. Response was weak, perhaps because the process and issues were not yet clearly defined.

### Spring 1996 Forum

In April and May of 1996, citizens and officials commented on a preliminary list of identified alternatives and a suggested set of values, objectives, and performance measures, which would become the evaluation criteria.

The feedback form for this forum asked participants to comment on the proposed criteria, suggest other criteria, and distribute a total of 100 points among the five suggested criteria (and others if they wished) to indicate their relative importance. Of the 168 people who attended these forums, 46 submitted feedback forms. The most striking feature of the feedback received was the overwhelming consensus that no one criteria should be considered too predominately. Only two out of 46 respondents assigned more than 25 of the 100 points to any one of the five criteria.

The feedback indicated general agreement with the criteria set forth, although it also brought to the fore two issues that are beyond the scope of the current project. First, there is growing concern about Albuquerque’s rate of growth and its costs. Second, people strongly favor regional mechanisms and regional solutions.

## **Fall 1996 Forums**

In September 1996, citizens and officials were brought up to date and given an opportunity to comment on the preliminary prioritization and ranking of the alternatives. More than 160 people attended these forums. The feedback form for these forums focused on sounding out participants about what they viewed as the pros and cons of alternative approaches.

In general, people focused on the need for action, with little concern among most about the specific alternative to be selected. As long as sustainability, public safety and environmental protection were assured, few people had strong preferences for one approach over another. Again, issues related to the role of water supplies in managing growth and regional solutions were common.

Participants were asked to indicate how much more per month they thought the average Albuquerque ratepayer would be willing to pay to have a sustainable water supply, with the potential responses ranging from none to more than \$12 per month more. Their response, while not representative of the ratepayer base as a whole, showed that virtually all felt that people were willing to pay more, and more than a quarter felt people were willing to pay more than \$12 per month more.

## **Spring 1997 Forums**

A forum presenting the recommended strategy was conducted in late March 1997. In addition, a town meeting sponsored by the City Council and Mayor will focus public discussion on the recommended strategy at about the same time. Additional public involvement will occur before a City Council vote on the recommended strategy.

## **Stakeholder and Community Meetings**

The project team has made an extraordinary effort to open and maintain a dialog with the 80 stakeholder groups identified at project kickoff. This has included not only the direct mail pieces and forum invitations mentioned above, but also a full schedule of speaking engagements and meetings. Throughout, we have sought a wide range of views regarding which strategy alternatives would be likely to gain the widest acceptance and provide the most value.

The City's water resources program manager has spoken to approximately 30 community groups in the course of the project. At these meetings, all interested parties have been informed of the course of the project to date and how they can participate.

In addition, project team leaders have met with dozens of individuals and organizations that have a focused interest in the new strategy. In some cases, several meetings have taken place with the same people. This has included elected officials from neighboring jurisdictions, the Middle Rio Grande Conservancy District (MRGCD) Board, the State Engineer and other regulatory officials, Pueblo leaders, and state and federal agency officials, among many others.

## Field Trips

In addition to the field trip held to acquaint CAC members with water facilities, the project team sponsored two field trips to promote a better understanding of the San Juan-Chama Diversion Project and its role in Albuquerque's water future.

The first of these was held in September 1996. Community leaders and water experts embarked on a float down the Rio Chama between El Vado and Abiquiu Reservoirs—the same route that the City's San Juan-Chama water takes.

The second was held for Pueblo leaders and legislators. In November 1996, the project team took Pueblo and State officials to the outlet in northern New Mexico where San Juan-Chama Diversion Project water enters the Rio Grande Basin. The group then followed the course the water follows to Heron Reservoir, down the Rio Grande to Albuquerque. The trip included informal presentations by Bureau of Reclamation staff that operate the San Juan-Chama project and discussions among state legislators, Pueblo officials, and the City's project team.

## Information Materials

The project team prepared a variety of graphic, printed, and video materials designed to assist in public outreach and education. Most of these materials were available at the public forums, all were available on request via the Water Resources Information Line, and some were mailed to selected groups from the interested parties database.

## Fact Sheets

The project team prepared 13 brief fact sheets on topics that were believed to be of major importance to the project and easily confusing to an interested member of the general public. These sheets were available at the forums. Topics included:

- *Albuquerque's Water Future* (rationale for the project)
- *Our Regulatory Partners*
- *Toward a Sustainable Water Supply* (defining the drought reserve, sustainability)
- *Surface Water Treatment*
- *The Endangered Species Act*
- *From the Drawing Board to Your Tap: What It Takes to Implement a Water Project*
- *Facts About Current and Future Water Costs* (discussion of the value of water)
- *Wastewater Reuse*
- *The Inner Valley: The Shallow Ground Water System*
- *Environmental Impacts of City Surface Water Use* (results of preliminary studies)
- *How the River and the Aquifer are Connected and the Water Rights Question Involved*
- *Water: From the River to Our Customers* (surface water diversion alternatives)
- *A New Water Resources Strategy* (explanation of the recommended strategy)

## Citizens Briefing Booklet

The project team prepared a briefing booklet covering the basic background and issues involved in the project and including graphics and a question-and-answer section. More than 700 of these booklets have been distributed. It was available at the forums and was

mailed with a cover letter to about 50 groups over the course of Phase 2. This general overview proved to be useful throughout, despite the development of new data and project progress, and was quoted in the press. Among the many groups receiving the Citizens Briefing were:

- The League of Women Voters
- Leaders of the Sandia, Santa Ana, Isleta, Acoma, Cochiti, Jemez, Laguna, Picuris, Pojaque, San Felipe, San Juan, Santa Clara, Santo Domingo, and Tesuque Pueblos
- Middle Rio Grande Conservancy District Board members
- Bernalillo County officials in several County departments
- Bureau of Indian Affairs officials
- City officials in Santa Fe, Belen, Los Lunas, and Rio Rancho
- Middle Rio Grande Council of Governments Board and staff
- Sierra Club
- Hispano Chamber of Commerce
- Albuquerque Economic Forum
- Coalition of Neighborhoods
- Shared Vision
- Albuquerque Board of Realtors
- Duke City Civitan
- University of New Mexico professors and students
- League of Neighborhoods

## Citizen Summaries

The project drew on several major studies, some of which were conducted simultaneously. The studies contributed major concepts and data—for example, concerning the drought reserve and land-use impacts—to the alternatives formulation and evaluation. In addition, they defined broad terms and approaches that will continue to be part of the regional and local water resources debate for some time to come.

So that the full range of interested parties could understand the thinking behind some of the critical ideas covered, the project team prepared Citizen Summaries (similar to executive summaries) of the Phase 1 *San Juan-Chama Diversion Project Options Report*, the *Value of Water* study, the *Middle Rio Grande Valley Water Assessment*, and the USGS' *Plan of Study* reports. The summaries appear as appendices to the Phase 2 *Summary Report* and will be used as implementation and regional outreach efforts move forward.

## Other Graphics and Presentation Materials

As is evident from this summary, project team leaders devoted a substantial amount of time to presenting the project rationale and progress to extremely diverse audiences within Albuquerque and throughout the region. Moreover, the concepts involved are ones that are often complex and unfamiliar to the nonexpert. A major effort was made to educate the broadest range of interested parties.

To support these efforts, the project team developed a standard format for and prepared overhead transparencies, mounted posters, and other graphic and written presentation materials suitable for the audiences in question. This included developing icons to represent alternatives and criteria, explanatory maps, and schematics of key concepts. These graphics were used not only by the project team, but by the media and others discussing project concepts. These materials constitute a “library” that will be useful in the continuing regional debate of water resources issues.

In continuing to develop public awareness of water issues, the project team is also taking advantage of water conservation program activities. This includes publishing articles in the conservation newsletter and providing hand-outs on water resources at conservation workshops and events.

## Videos

The Public Works Department has prepared several video presentations, including public service announcements, as part of its water resources and water conservation efforts. These widely broadcast communications tools have contributed to the public awareness needs of the Water Resources Management Strategy project as well as to conservation.

The first, *Before the Well Runs Dry* dealt with the limited nature of water resources in the Albuquerque basin, pointing to the need for both conservation and water resources planning. *Before the Well Runs Dry* includes interviews with the Mayor and other community leaders, as well as technical information about the water supply. It was originally produced as a 30-minute program that was aired on KOB-TV Channel 4 (NBC affiliate) in June 1994. An estimated 75,000 people viewed this program. Since that time, it has been aired on several local stations, and repeatedly on Channel 14 (public access channel). In addition more than 1,000 copies of 30-minute and 15-minute versions of the video have been distributed to libraries, schools, and other interested parties.

*Quenching Our Thirst: Meeting Albuquerque's Water Challenge*, another half-hour prime time television special aired in the spring and summer of 1996 on KOB TV, Channel 4, and KNME TV (public broadcasting station). About 500 copies of this video have been distributed. Again, the program dealt with water resources issues relevant to both conservation and supply development.

An estimated 150,000 people viewed *The San Juan Chama: A Tale of Two Legacies* aired during prime time on November 30, 1996 on KOA-TV Channel 7 (ABC affiliate). This video showed the source of San Juan-Chama water and the its potential role in City plans. The program has subsequently aired on KNME-TV and on Channel 14 TV. About 400 copies have been sent to community leaders.

The Public Works Department also used computer animation provided by Los Alamos National Laboratory to prepare a short video showing the probable effects of different

ground-water use scenarios on the water table in the aquifer. This video was used in presentations to various groups and as a continuously running premeeting display at the forum on preliminary evaluation results in the fall of 1996.

## **The Role of Public Involvement**

The project team believes the public involvement efforts undertaken to date and those planned for the future constitute a key part of the Water Resources Management Strategy. These efforts have greatly enhanced the team's ability to craft alternative strategies that are responsive to public and regulatory concerns and to realistically evaluate the options open to the City.

The projects and policies that comprise the recommended strategies reflect not only immediate water needs, but also the more general concerns and attitudes gathered through public involvement activities. Among the longer term concerns are those stressing that water planning needs to be integrated with other City planning functions and those of the region as a whole.